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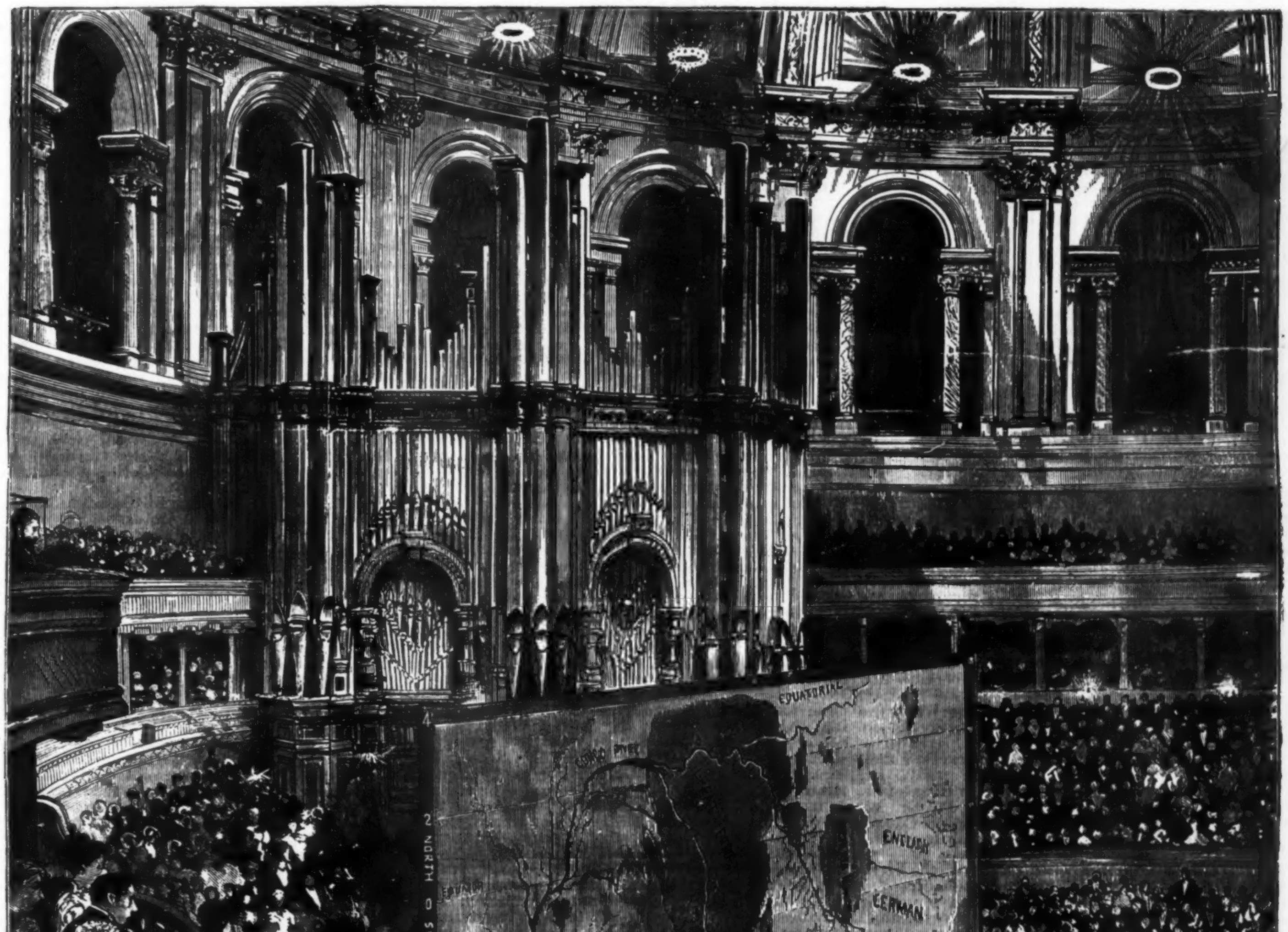


MR. STANLEY LECTURING BEFORE THE ROYAL GEOGRAPHICAL SOCIETY, AT THE ALBERT HALL, LONDON.

MR. STANLEY'S ADDRESS TO ROYAL GEOGRAPHICAL SOCIETY.

ON Monday, May 5, in the Albert Hall, London, the Royal Geographical Society held a meeting, which will long be memorable in the history even of that great society, to receive Mr. Stanley on his return from Africa. The hall was filled to the remotest corners of the galleries, making a complete circle from the organ, and at 8.30, the hour fixed for the president, Sir M. E. Grant-Duff, to take the chair, there were 8,000 in the hall. All that is distinguished in literature, art, science, and travel, with a large sprinkling of social and political celebrities, was represented. On the arrival of the royal party the organ pealed out the national anthem and the brilliant assemblage gave a lusty cheer as a procession, in which the central figures were the Prince of Wales and the Duke of Edinburgh, followed immediately by the President of the Royal Geographical Society and Mr. Stanley, made its way down the center of the hall to the platform. As Mr. Stanley proceeded to his seat the cheering was renewed. On the right of the chairman sat Mr. Stanley, and on his right the Prince of Wales. On the left was the Duke of Edinburgh. In front of the platform there was a magnificent display of lilies and ferns and other plants. In the front row facing this bank of flowers were gilt arm-chairs, half a dozen on the right being for her Royal Highness the Princess of Wales and her party, and a corresponding number on the left for the Duchess of Edinburgh and her children. This was the only part of the hall, however, in which were empty seats. On the right of the Prince of Wales were seated Dr. Parke, Captain Stairs, Captain Nelson, Mr. Mounteney Jephson, and Mr. Bonny, who as they where recognized came in for cordial cheers. The following are some of the names that appear in the official list of those present: The Prince and Princess of Wales, Princess Victoria of Wales and Princess Maud of Wales, the Duke of Edinburgh, the Duke and Duchess of Teck and the Princess Victoria of Teck, the Duke of Cambridge, Prince Christian, the Prince and Princess Victor of Hohenlohe, the Duke of Fife, the Duke of Argyll, the Comte de Paris, the Archbishop of York, Earl and Countess Granville, the Earl and Countess of Rosebery, Viscount and Lady Sherbrooke, Sir Frederic Leighton, Mr. Mundella, M. P., Sir William and Lady Harcourt, Sir M. Hicks-Beach, M. P., Sir Richard Webster, M. P., Sir Frederick and Lady Abel, Sir Frederic Bramwell, Viscount Cross, Sir Edward and Lady Clarke, Sir Henry James, Sir S. and Lady Ponsonby-Fane, Lord Justice Fry, Count Hatzfeldt (the German Ambassador) and Countess Mary Hatzfeldt, the Greek Minister, Sir John Gorst, M. P., Sir Henry and Lady Hawkins, the Italian Ambassador, Lord and Lady Knutsford, Lord Justice Lindley, Sir Halliday and Lady Macartney, the Lord Mayor and the Lady Mayoress, the Netherlands Minister, Sir R. G. W. Herbert, Mr. John Morley, M. P., Mr. Ritchie, M. P., Professor Max Müller, M. Julius Leclercq (President of the Brussels Geographical Society), M. Bertrand, M. Paul B. Du Chaillu, Sir Henry Barkly, Commander Cameron, Mr. and Mrs. Joseph Chamberlain, Mr. Henry Matthews, M. P., Sir Saul and Lady Samuel, Sir Charles and Lady Tupper, Mr. Justice Wills, the Dean of Westminster and Mrs. Bradley, Sir Albert Rollit, M. P., Baron H. De Worms, M. P., Mr. Justice Denman, the Danish Minister and Madame De Falbe, the Vice-Chancellor of Cambridge University, Dr. Welldon (of Harrow School), Mr. F. W. Walker (of St. Paul School), Mr. Ashmead-Bartlett, M. P., Mr. W. Sinclair, M. P., Mr. Raikes, M. P., Mr. Burdett-Coutts, M. P., Mr. White (Secretary to the American Legation), Sir Lewis Pelly, and Sir William Mackinnon.

In a few studied and pregnant sentences the President briefly introduced Mr. Stanley, sketching his great services in exploration from his first meeting with Livingstone—a name, said the President, amid subdued cheering, which could never be mentioned without honor. There was some anxiety as to whether Mr. Stanley's voice would fill the great rotunda, but the doubt was resolved, as from his first sentence his voice sounded clear and sonorous, and was distinctly heard in the galleries. Behind him, half concealing the organ, was a large map specially prepared for the meeting and showing in the center the vast equatorial forest in which the travelers suffered so much. To this map he occasionally referred, but it was on such a scale that the audience could follow at a glance the narrative.

As soon as the address was over and the vote of thanks passed, the principal function, for which the meeting was indeed convened—the presentation of medals to Mr. Stanley and his gallant companions—was proceeded with. Mr. Stanley, as is well known, had already received one of the royal medals of the society, and the council determined that the most suitable manner of putting on record their sense of the skill and energy shown in his last journey across Africa and of the importance of the geographical results obtained in the linking of the old Equatorial Province of Egypt and the territories of the Congo State, the discovery of a new source of the Nile, the restoration to their true place in maps of the legendary snow-capped Mountains of the Moon, and the enlargement of the Victoria Nyanza by a new bay, would be to strike a special medal for Mr. Stanley and his European officers. Acting on the advice of the officials of the medal department of the British Museum, the designing of the medal was intrusted to Miss E. Hallé, whose medals of Herr Joachim and Cardinal Newman are well known. As a reproduction of the two sides of the medal is placed as a frontispiece in the May number of the "Proceedings," it is needless to describe at length its character. The head of Mr. Stanley has been modeled from Professor Herkomer's portrait and numerous photographs taken before his departure. The design on the reverse shows a female figure, the Africa of classical tradition, wearing on her head a helmet in the design of an elephant's head, and pouring from urns the two great rivers Mr. Stanley has done so much to throw light on. A lake, a great mountain, and a tropical forest form an appropriate background. The gold of the medal had been supplied to the council by Mr. Pritchard Morgan, M. P., who has liberally presented it from his Welsh mines. Bronze copies of the medal were presented to each of the European officers connected with the expedition. For Mr. Stanley's colored followers a silver star has been designed, which will bear in the center the monogram of the Royal Geographical Society, and the words, "Emin Relief Expedition, 1887-89." The medals lay on the table before the President, and as they were one by one presented to Mr. Stanley, Captain Stairs, Dr. Parke, Captain Nelson, Mr. Mounteney Jephson, and Mr. Bonny, there was much cheering, but it should be added that the demonstration in honor of Dr. Parke was very emphatic.

The PRESIDENT: Your Royal Highnesses, Ladies and Gentlemen: Those who have welcomed or will still welcome Mr. Stanley have, or will have, regard chiefly to the philanthropic, to the commercial, or to the political possibilities of the future. I suppose that most of us as individuals are interested in one or other or all of these matters. But the Geographical Society, as a society, is interested only in the extension of man's knowledge of his environments. It is because Mr. Stanley has done so much to extend that knowledge that we have convened this enormous gathering, far the largest which has ever come together under our auspices. Of Mr. Stanley's recent travels I will say nothing. He is here to tell you about them for himself. But I should like in a single sentence to record the principal things which Mr. Stanley did for geographical science before he entered upon his recent expedition. In the first place, along with Livingstone—a name never to be mentioned without honor (cheers)—he explored the northern portion of Lake Tanganyika, and settled the question, then much debated among geographers, whether the Nile did or did not take its rise in those ample waters. That question he settled in the negative. Then upon his second expedition he traced down the Shimeyu River, which flows from the south about 300 miles in to the Victoria Nyanza, and is accordingly one of the ultimate sources of the Nile. Thirdly, he circumnavigated the Victoria Nyanza, which is only a very little smaller than Lake Superior, the largest of all fresh water seas in the world. Fourthly, he discovered Lake Albert Edward, which he named in honor of his Royal Highness (cheers), on whose presence we congratulate ourselves to-night. (Cheers.) Next he circumnavigated Lake Tanganyika and showed that it discharged its waters into the Lualaba through the Opoco. Than he traced the Lualaba itself, and settled the question which possessed the mind of Livingstone so much in his last years, what the Lualaba really was, whether it was the Nile or the infant Congo. Stanley proved that it was the infant Congo. Seventh and lastly, he traced the Congo down to the sea through an Odyssey of wandering and an Iliad of combat; and by that means he threw open to the enterprise of civilized man a territory fully as large as that of British India. (Cheers.) These are mighty achievements, and it must be remembered that in all of them, as in the last journey, which has been equally fruitful of geographical discovery, Mr. Stanley was his own surveyor, his own astronomical observer, and the recorder of his own actions. You will then not think it surprising, and I am certain that I shall have the full support and sympathy of every person here present, when, in the name of the Royal Geographical Society and by its authority, I give its warmest thanks to Mr. Stanley for what he and his companions have done for geographical science. (Cheers.) We thank him and we thank them all, white or black, living or dead. That gifted man too early lost to geographical science, to letters, and to the state, the last Lord Strangford, said of Mr. Gifford Palgrave, when the letter returned from Arabia and recounted his journeys to us, that there had been nothing like it since Herodotus recited at Olympia. I do not know whether Herodotus ever really recited at Olympia. Of this I am certain, if he ever did so, that he did not address an audience either so numerous or so distinguished as that which is here assembled; and in all that mighty audience there is not one single human being who is not delighted to see and impatient to hear the illustrious explorer whom I now invite to address you. (Cheers.)

Mr. STANLEY, who was again cheered, said:

Your Royal Highnesses, Mr. President, Ladies and Gentlemen: I feel sure there is not a person present who, if he knew my feelings at this moment, would wish to be in my place. (Laughter.) I stand apparently in a very desirable position, in close proximity to the heir to the throne of England and to his royal brother, the object of hearty welcome; but I feel inexpressibly grieved that I am able to render so poor a return for your kindness. Matter enough I possess to fill many hours of interest for you; but, unfortunately, I have ha l no time to prepare anything that I would call worthy of this great assembly. I therefore hope that in addition to the warm welcome you have given me, you will be lenient in your judgment of the merits of what I am about to tell you this evening. (Loud cheers.)

THE FOREST.

Our late journey for the relief and rescue of Emin, the Governor of Equatoria, was over 6,000 miles in length and occupied us 987 days. Five hundred of those days were passed in the great Central African forest, and for 487 days we lived or journeyed through grass lands. Let us talk of the forest first.

A writer on Africa lately wrote a book wherein he said: "Day after day you may wander through these forests with nothing except the climate to remind you where you are. The fairy labyrinth of ferns and palms, the festoons of climbing plants blocking the paths and scenting the forests with their resplendent flowers, the gorgeous cloud of insects, the gayly-plumaged birds, the paraquets, the monkeys swinging from the lias trapeze in the shaded bowers—these, these are unknown to Africa."

Once a week you will see a palm, once in three months the monkeys will cross your path, the flowers on the whole are few, the trees are poor, and, to be honest—nay, if this is honest description I must close right here. We have traveled 1,670 miles through the great forest of equatorial Africa, and we are compelled to declare that the writer's description of Africa is altogether wrong, that it bears no more resemblance to tropical Africa than the tors of Devon resemble leafy Warwickshire, the gardens of Kent, and the glorious vales of this island. Nyassaland is not Africa, but itself, and only a small section of a great continent which embraces over 11,000,000 of square miles.

Let me guide you rapidly through this forest, and I promise you not to mislead you.

Its greatest length is from near Kabamberre, in South Manyuema, to Bagbomo, on the Welle-Makua, in West Niam-Niam, 621 English miles; its average breadth is 517 miles, which makes a compact square area of 321,057 square miles. A serpentine line through the center of this would represent our course. This enormous tract is crammed with trees varying from 20 ft. to 200 ft. high, so close that the branches interlace one another and form an umbrageous canopy.

It is absolutely impenetrable to sunshine. While the sun scorches and dazzles without, a little dust of white light flickering here and there only reveals the fact. Generally it was a mystical twilight, but on misty or rainy days the page of a book became unreadable. At night one fancied that the darkness was palpable and solid.

The moon and stars were of no avail to us. As there are about 150 days of rain throughout the year, and almost every rainfall except a drizzle is preceded by squalls, storms, tempests, or tornadoes, with the most startling thunder crashes and the most vivid flashes of lightning, you may imagine that the houseless traveler in such a region must endure much discomfort.

I have passed far more hours than I would like to say spellbound with wonder during various phases of existence within it. I have caught myself often unconsciously wondering at the strange resemblance to human life visible in the forest. It was represented here very faithfully in all its youth, vigor, and decrepitude. There are trees prematurely aged and blanched, others were tumorous, others organically weak, others were hunchbacks, others suffered from poor nutrition, many are pallid and shrunk from want of air and sunshine, many were supported by their neighbors because of constitutional infirmity, many are toppling one over another as though they were the incurables of a hospital, and you wonder how they exist at all.

Some are already dead, and lie buried in reeking composts of humus, some are bleached white by the palsying thunderbolt, or shivered by the levin brand, or quite decapitated, or some old veteran, born long before the siege of Troy, is decaying in core and vitals; but the majority have the assurance of insolent youth, with all its grace and elegance of form, the mighty strength of prime life, and the tranquil pride of hoary aristocrats, or the placid endurance of ripe old age. All characters of humanity are represented here except the martyr and the suicide. Sacrifice is not within tree nature, and it may be that they only heard two divine precepts, "Obedience is better than sacrifice," and "Live and multiply."

And as there is nothing so distasteful to me as the mob of a race day, so there is nothing so ugly in forest nature as when I am reminded of it by the selfish rush toward the sky in a clearing the hour it is abandoned by the human owners. Hark, the bell strikes, the race is about to begin. I seem to hear the uproar of the rush, the fierce, heartless jostling and trampling, the cry, "Self for self, the devil take the weakest," to see the white hot excitement, the noisy fume and flutter, the curious inequalities of vigor, and the shameless disregard for order and decency.

I have sat at my tent door watching the twilight deepen into a sepulchral gloom, knowing the elements were gathering for a war with the forest. I have heard the march of the storm advancing with the speed of a hurricane and the sullen roar of the forest, as with nerves collected it swung its millions of giant heads to wrestle with it; the groaning, and rending, and crashing. I have seen the mighty swaying and surging of a countless army of tree tops and their leaves all quivering and rustling, and the undergrowth dancing as though in approval of the strength of its gray sires, and then I have heard the rain follow in a torrential downpour, hushing the storm and the strife, and descend in cascades from the drowning trees. We have watched the humus absorbing the rainwater as it fell until like a sponge it was full, and the water rising by inches around us, and for 12, 15, and 18 hours the rain has steadily poured until it seemed as though we were never to see dry ground again. And then, after an uneasy night, wakened now and then by a falling tree which made the earth quake, or an unusual thunderclap overhead, as loud as if a planet had exploded. I have sat and watched the steaming vapor rise in blue clouds and sail up among the still foliage in ever-thickening folds, and have wondered how the atmosphere would ever become clear again. Yet within a few hours the sun would be felt shining with purified luster again, and every now and then as some strata of foliage would be lifted by a sportive breeze there would be subtile changes of light, and the dull green and damp leaves would shine with fitful life.

When there is so much vigorous life round about us in these eternal woods, it did seem strange to us that vegetable life was so incommunicable with our own. But yesterday we sympathized with trees as they roared in pain and torment, battling with the angry storm, and as they stand now, so spectral and still in mute peacefulness, still so keen are our sympathies with them that one fancies there should be some mode of speech between us and them. I saw that some were many centuries old, some in prime life with every fiber healthy, some glorious in youth and strength, some goitrous, warty, ulcerous, stunted, and unwholesome, some slaves of slaves strangled by rigid clutch of a pythonous parasite, the parasite in its turn bound firm with exceeding tension by a snaky creeper, and that also covered with lichen and moss, some with great sores exuding globules and pastils of gummy matter, the ants feeding on them like flies on pus, some old, ancient, palsied by a lightning stroke, life, death, and decay all around as with us.

I have been absorbed in comparing the existence of some of these tree kings with events of human history. That splendid palm by the riverside took root half a century before the great plague of London. Yonder stately bombax springing up a head and neck above myriads was born probably about the time of that memorable scene on Calvary; that rinkled ironwood, 4 ft. in diameter, was an infant under the shelter of his old sire when the Tower of Babel was building.

And what office, if any, may one of these forest giants hold, whose blossoming crown and globe of foliage rise so high above the herd? Is it that of a watchman looking out for tidings? Is he the sire of the tribe? Does it herald the dawn and the morning sun, and bid the trees unfold their buds, and shake their leaves for rejoicing? Or has it gained such proud pre eminence by its selfish and exuberant vitality? But lo! the storm ap-

proaches, there is fury and wrath, the thunderbolt falls, and the proud king falls, severed at the neck. You almost hear the cry of "The king is dead, long live the king!"

Since I have made my map I have taken the trouble to measure the extent of the area covered by this forest, and I find it to be something like 224,000,000 acres, and if we allow each tree 30 ft. around for sufficient space, and only 48 trees to the acre, we have the colossal figure of 10,752,000,000 as the total number, and if we calculate the plants and saplings of the impenetrable undergrowth, we shall be among the incalculable billions.

THE PYGMIES.

The longevity of the animal creation found in the rivers and shades of these aged woods is something worth glancing at. The elephant and the hippopotamus and the crocodile may boast of their 400 years of life, the tortoise a century, the buffalo 50 years, the crows, eagles, ibis, and touracos nearly a century, the parrot, the heron, and flamingo 60 years.

From the chimpanzees, baboons, and monkeys, with which the forest abounds, is but a step, according to Darwinism, to the pygmy tribes whom we found inhabiting the tract of country between the Ihuru and Ituri rivers. They were known to exist by the Father of poets nine centuries before the beginning of the Christian era. You may remember Homer wrote about the sanguinary battle that was reported to have taken place between the pygmies and the storks. In the fifth century before Christ Herodotus described the capture of five young explorers from Nassamoves while they were examining some curious trees in the Niger basin, and how the little men took them to their villages and showed them about to their fellow pygmies much as you would like us to show the pygmies about England. The geographer Hekatæus in the fifth century located the pygmies near the equator of Africa, under the shadows of the Mountains of the Moon, and I find that from Hipparchus downward, geographers have faithfully followed the example of Hekatæus, and nearly a year ago we found them where they had been located by tradition under the names of Watwa and Wambutti. The forest which we have been just considering extends right up to the base line of the Mountains of the Moon.

We were just now paying due reverence to the kings of the forest who were born before the foundations of the tower on Shinar plain were laid, and because it seemed to us that in their life they united pre-historic times to this society-journal-loving 19th century. Let us pause a little and pay honor to those little people who have outlived the proud Pharaohs of Egypt, the chosen people of Palestine, and the emperors of Babylon, Nineveh, Persia, and the Macedonian and Roman empires. They have actually been able to hold their lands for over 50 centuries. I have lately seen the wear and tear on the Pyramids of Egypt, and I can certify that the old Sphinx presents a very battered appearance indeed, but the pygmies appeared to me as bright, as fresh, and as young as the generation which Homer sang about.

You will therefore understand that I, who have always professed to love humanity in preference to beetles (loud laughter), was as much interested in these small creatures as Henry Irving might be in the *personnel* of the Lyceum. Near a place called Avetiko, on the Ituri river, our hungry men found the first male and female of the pygmies squatted in the midst of a wild Eden peeling plantains. You can imagine what a shock it was to the poor little creatures at finding themselves suddenly surrounded by gigantic Soudanese 6 ft. 4 in. in height, nearly double their own height and weight, and black as coal. But my Zanzibaris, always more tender-hearted than Soudanese, prevented the clubbed rifle and cutlasses from extinguishing their lives there and then, and brought them to me as prizes in the same spirit as they would have brought a big hawk moth or mammoth longicorn for inspection. As they stood tremblingly before me I named the little man Adam and the miniature woman Eve, far more appropriate names in the wild Eden on the Ituri than the Vukukuru and Akiokwa which they gave us. As I looked at them and thought how these represented the oldest people on the globe, my admiration would have gone to greater lengths than scoffing cynics would have expected. Poor Greekish heroes and Jewish patriarchs, how their glory paled before the ancient ancestry of these manikins! Had Adam known how to assume a tragic pose, how fitly he might have said, "Yea, you may well look on us, for we are the only people living on the face of the earth who from primeval time have never been removed from their homes. Before Yusuf and Mesu were ever heard of, we lived in these wild shades, from the Nile Fountains to the Sea of Darkness, and, like the giants of the forest, we despise time and fate."

But, poor little things, they said nothing of the kind. They did not know they were heirs of such proud and unequaled heritage. On the contrary, their faces said clearly enough, as they furtively looked at one and the other of us, "Where have these big people come from? Will they eat us?" There were some nervous twitches about the angles of the nose and quick upliftings of the eyelids, and swift, searching looks to note what fate was in store for them. It is not a comfortable feeling which possesses a victim in the presence of a possible butcher and a possible consumer of its flesh. That misery was evident in the little Adam and Eve of the African Eden. The height of the man was four feet, that of the woman a little less. He may have weighed about eighty-five pounds; the color of the body was that of a half-baked brick, and a light brown fell stood out very clearly. So far as natural intelligence was concerned, within his limited experience, he was certainly superior to any black man in our camp. The mysteries of woodcraft, for instance, he knew better than any of us, he knew what wild fruits were wholesome, and what fungi were poisonous. He could have given us valuable lessons how to find our way through the forest. I saw also that he could adapt himself to circumstances. If the pot was to end him, a very little shrinking only would betray his fear of pain; if he were to be treated affectionately, none could be so ready to appreciate affection and kindness.

We began to question him by gestures. "Do you know where we can get bananas?" He catches the cue, he grasps his leg to show us the size and nods his head rapidly, informing us that he knows where to find bananas of the size of his leg. One sees that he can exaggerate as well as Mark Twain. (Laughter.) We point to the four quarters of the compass, questioningly. He points to the sunrise in reply. "Is it far?" He shows a hand's length. Ah, a good day's journey without loads, two days with loads! "Do you know the Ihuru?" He nods his head rapidly. "How far is it?" He rests his right hand sideways on the elbow joint. "Oh, four days' journey." "Is there much food on the road?" He pats his abdomen lovingly with an artful smile, and brings his two hands to a point in front of him, from which we may infer that our paunches will become like prostrate pyramids. We ask him why Aveliko has so little food. The little man attempts to imitate the sound of gunshots and cries, "Do-o-o-o," and we are informed quite intelligently that the devastation is due to the Manyuema.

I suppose we must have passed through as many as one hundred villages inhabited by the pygmies. Long, however, before we reached them they were deserted and utterly cleaned out. Our foragers and scouts may have captured about fifty of these dwarfs, only one of whom reached the height of fifty-four inches. They varied from thirty-nine inches to fifty inches generally. They are so well proportioned that at first sight they might be taken for ordinary mankind, but when we place by their side a European, a Soudanese, or a Madi they appear exceedingly diminutive. By the side of dwarfs of mature age, a Zanzibari boy of thirteen would appear large.

The agricultural settlements in this region are to be found every nine or ten miles apart, and near each settlement, at one hour's march distance, will be found from four to eight pygmy villages situated along the paths leading to it. The larger aborigines are very industrious, and form a clearing of from 400 to 1,000 acres. Amid the prostrate forest they plant their banana and plantain bulbs. In twelve months the prostrate trees are almost hidden by the luxuriant fronds and abundant fruit, of unrivaled quality, size, and flavor. It would be easy to prove that in the forest an acre of banana plants produces twenty-five times more food than an acre in wheat produces in England. The pygmies appear to be aware that a banana plantation is inexhaustible, and to think that they have as much right to the produce as the aboriginal owners. Therefore they cling to these plantations and make the larger natives pay dearly for the honor of their acquaintance. In another manner they perform valuable service to them by warning them of the advance of strangers and assisting them to defend their settlements; they also trap game and birds, and supply the larger natives with peltry, feathers, and meat. It appeared to me that the pygmies were regarded somewhat as parasites, whose departure would be more welcome than their vicinity. When honey, and game, meat, peltry, and feathers get low or scarce in the neighborhood, the pygmies pack their household goods on their women's backs, and depart elsewhere to attach themselves to some other plantations. A forest village consists of from twenty to one hundred families of pygmies, and probably in that area between the Ihuru and Ituri rivers there are as many as two thousand families living this nomadic and free life in the perpetual twilight of the great and umbrageous forest of equatorial Africa.

Having within the brief time permissible considered the forest and its inhabitants, let us take up the subject of the pastoral land and its tribes.

THE PASTORAL LAND AND ITS TRIBES.

In equatorial Africa the pasture land adapted for cattle generally begins at an altitude of 3,200 ft. above the sea, but the best and most nourishing grasses are found above 4,000 ft.

The forest ends completely at 3,500 ft., and the land soon afterward varies from 4,000 ft. to 6,000 ft., and extends in a parallel belt with the Albert Lake, and between the Lakes Victoria and Tanganyika down to Ukawendi, and from Abyssinia and east of the Victoria down to the Rufiji.

In the intra-lake region are the nations of Ankori, Uganda, Unyoro, Karagwe, Mpororo, Ihangiro, Uhaiya, Uzongora, Uzinja, Ruanda Urundi, Ubha, and Unyamwezi.

On the grassy plateau parallel with Lake Albert we found quite a mixed race called the Bavira, Balegga, and Wahuma. The latter named differ as much in their physiognomy, customs, and characteristics from the other two as an octoroon differs from a negro. The Wahuma are very numerous in Unyoro and Uganda throughout the intra-lake region, especially in Ankori. Their sole occupation is keeping cattle.

As you proceed further south and reach Unyamwezi, the Wahuma become known as Watusi. In Unyoro they are known as Waima and Wachwezi, among the Bavira and Balegga they are called Wawitu, but all the Wahuma, Wachwezi, Wawitu, and Watusi speak the same language, therefore we class them under the generic term Wahuma. They are distinguished from among the agricultural classes, with whom they live as herdsmen, by their complexion, length of limbs, small heads and ears, long slender hands and feet, and regular features.

Among the purest families these distinctions are very marked, the complexion being frequently like the color of yellow ivory. They do not hesitate to tell us disdainfully that they are not hoemen, if we seek to purchase grain or potatoes from them.

The produce of their dairies suffices, with a few hides, to purchase all the vegetable food they need. They will live among the hoemen, and allow their cattle to graze on the pasture in the land, but will build their huts and zeribas separate and apart all together from the villages of the other class; they will employ female servants, or own female slaves, but they will not cohabit with them. And the Wahuma race grow side by side with the darker agricultural class without taint, by preserving their customs intact.

Wheresoever they obtained the idea, they believe that the other class is infinitely below them, and absolute destruction of their communities and disruption of the families will not induce them, except on very rare occasions, to mingle their blood with any of the agricultural class.

But yet, as we proceed further south, we find that at some time there has been an admixture of the two races, which has produced a composite race which unites the characteristics of both the superior and inferior race, and who are both agriculturists and herdsmen combined, as in Europe.

It has been a subject of engrossing interest to me to discover why I find among a nation in the far interior pure negroes, a composite of the Wahuma and negroes, and the pure Wahuma.

I am about to give you the deductions drawn from about 24,000 miles of travel in Abyssinia, Ashantee, the Livingstone search, across Africa, two expeditions up the Congo, the exploration of certain tracts on the east coast and elsewhere, with this last expedition for the quest and rescue of Emin.

Probably many of you have had an idea that the Africans are all negroes, and I feel sure that if the various types of Africans were suddenly presented to you on this platform you would still be ready to affirm that they were negroes; but you must permit me to say that you would commit a grave error.

I have already spoken to you of one race inhabiting that great equatorial forest, the pygmies, who are a diminutive negro race, despite the fact that it is divided into two distinct types—the dark, long-headed, prognathous-jawed, and a lighter, round-headed, broad-faced type.

You also know the true negro of west and southeast Africa, characterized by woolly hair, expanded nose and sunken nasal ridge, fat everted lips, and exceeding prognathy; you also know the tall warlike Zulu and Caffre, who are not pure negroes, but negroid—you must accept them as types of the composite race I just spoke to you about.

Next comes the Mhuma, and if you wish a rough and ready picture of him, you must imagine a traditional lanky New Englander, darkened with burnt cork, with a negroid wig, or plant a Zulu and a Hindoo before you and produce an Indo-African type out of the compound—features regular, hair curly but silky, small round head, shapely neck, small thin lips, small ears, slender hands and feet, tall, and perfect in figure from the knees upward. That is the representative of the Wahuma, who disdain the use of the hoe, and despise the planter and the sower, and will not intermarry with the negro, and commit the awful crime of miscegenation, any more than the proudest Virginian in America. They came from Abyssinia a long time ago. They resemble the Abyssinians, Somalis, and Gellas. You may call them, if you will, Abyssinian or Ethiopic, but the comprehensive philosophic term would be Indo-African.

A fifth race is represented by the Semitic-African, who are to be found principally among the Mahdists to-day at Darfour, Kordofan, and Dongola. And a sixth race is found among the Berberines, as represented by the Tuaregs and Bedawy of Northwest Africa.

We must be satisfied for the present with concluding that the pygmies and the negroes are the primitive races of Africa, that Ethiopia in prehistoric times was invaded by various migrants from the great Aryan race—that as they multiplied they scattered southward and mixed with the negro tribes, and produced that composite race represented by the Zulus, Caffres, Bechuanas, Matabeles, Mafitte, Watuta, and Wanyamwezi. A later movement conveyed tribes having peculiar customs, who, finding the intra-lake region best adapted for their cattle, clung to the land and its rich pasture, indifferent to the fate of the tribes or nations employed in tilling the ground, and their clannish decendants are the Indo-African Wahuma.

THE SEMLIKI VALLEY.

Among the most interesting discoveries that we were enabled to make during our late expedition are the connection between the Lake Albert Edward and Lake Albert, the famous Mountains of the Moon, and the extension of Lake Victoria to the southwest. Lake Albert, discovered by Sir Samuel Baker in 1864, called Muta Nzige by the natives around it, begins in N. lat. 1° 10', or thereabout. Near its head there enters a powerful river 100 yards wide, 9 ft. deep, and a current of three knots. It is called the Semliki, and on following that deep sunken trough which is a prolongation of that occupied by the Albert Lake, we find, after following a winding course of 150 miles, that it issues from another Muta Nzige lake, now called Albert Edward, situated at an altitude of about 900 ft. above Lake Albert, or 3,307 ft. above the sea. At a distance from the right bank of the Semliki River of from 5 to 15 miles there rises a lofty range of snow mountains. As the snow line on the equator is found at 15,260 ft. above the sea, and as the height of snow visible above that was between 3,000 ft. and 4,000 ft., the altitude of the highest peak of Ruwenzori, as the Wahuma call it, must be between 18,000 ft. and 19,000 ft.

In the chapter on geology which I find in your last edition of "Hints to Travelers," I find a very peculiar sentence, which reads: "Few, if any, geologists now believe that mountains were simply thrust up from below." All I can say is that I am sorry for the geologists, for who that sees a pile of earth above a fox's hole will doubt that the material came from the hole? In the case of that trough 230 miles long and 30 miles wide, 3,000 ft. deep, occupied by the two lakes Albert Edward and Albert, and the Semliki Valley, in the midst of what was once an elevated plateau 5,000 ft. to 6,000 ft. above the sea, and seeing that enormous range upheaved above the plateau, who can doubt that the material came from that trough? The rocks of Ruwenzori are igneous; its serrated summits and their semicircular formation indicate the existence at one time of craters, and since the upheaval the sides have been grooved by glaciers, scoured by torrential rainfalls, and channeled into deep ravines by the threescore of streams and their affluents formed by the melted snows, and the *debris* has been spread over the Semliki Valley and into the beds of the two lakes.

I humbly crave your pardon if I say anything extraordinary, but my exceeding interest in the subject of the Semliki Valley leads me to suggest what I am about to say, in order that some gifted person connected with geology may turn his earnest attention to this theme and throw more light upon it. Thoroughly believing as I do that the abyss now occupied by the two lakes and the Semliki Valley was formed by a sudden subsidence, which compressed the vapors and gases beneath to be vented by the craters of Ruwenzori, I have been speculating as to what aspect the awful chasm bore after the volcanoes had belched their contents and formed the snowy range. Let us suppose that we are far back in the prehistoric period and look-

ing down from the western edge of the disrupted plateau into the profound abyss just formed. Ruwenzori is active, tall columns of smoke and fire spring up from the vents, rivers of lava pour down the sides, fragments of rock are hurled far up and fall crashing on the slopes, thundering down to the bottom, until nearly midway between the lakes are formed dikes of congealed lava and arrested rock, and in the course of time Ruwenzori has ceased to be disturbed, and rises in a series of caves formed of igneous rock and *debris*. The snows gather over what was lately molten rock, cinders, and huge fragments thrown up. The temperature in the bottom of the abyss is torrid; above the snow line it is below zero; but the heated vapors from below and the hot equatorial sun effect a constant descending movement of the snow above, and ruinous avalanches roll down crashing, and formidable glaciers drive irresistibly downward, each bearing masses of earth to restore the material whence it came, and the tropic rains begin to score and groove and channel and wash away the loose soil and fragments, some into the Albert Edward, and some into the Albert, and some into the valley, until at last they have arrived at the summit of their obstructions at their respective northern extremities, and when they are brimful they run over the Albert northward, through the lower level of the uplands north of Tunguru, the Albert Edward over the obstructive dikes in the Semliki Valley, and when that period has arrived let us try and discover what means we have at present for measuring the lapse of time. Thirteen years ago the French missionaries settled on Lake Victoria, and since then they have found that the lake has subsided three feet, which would be equal to two inches and eight-tenths of an inch per annum. If the upland at the north end of Lake Albert had then an average altitude of 2,000 ft. above the present level of the lake, it has required 8,666 years for Lake Albert to reach its present stage, if the White Nile escaping from the north end has worn away its reefs and dikes at the same rate that the Victoria Nile has worn the lip of its rocky obstructions at the Ripon Falls.

We have a second means of guessing within a certain number of centuries the age of the elapsed period in that recent increase in the extent of the Semliki Valley at the head of Lake Albert, and the exposure of the terrace at the southwest end, which rises gradually from the edge of the lake to the base of the plateau wall that suddenly rises 2,500 ft. behind it. From the south end of the lake to the end of the dense tropical forest there are about 30 miles in a straight line; the rise of the land is at the rate of two feet in a mile. For 20 miles of the distance the bed of the lake is covered with poor, innutritious grass; for the remaining ten miles it is covered with scrubby acacias which gradually become a thin forest, mixed with euphorbia and tamarinds, which are hardy trees. The forest gradually becomes thicker and more umbrageous, and here and there is a borassus palm. To expose that 30 miles of lake bed I estimate that it required between 260 and 300 years, and that length of time to enable the tropic rains to scour the salts and acrid properties from the earth in a sufficient quantity to enable those palms and tamarinds to grow.

On proceeding southward from the southern edge of the lake we first see soft alluvial mud deposited by the Semliki, then a saline earth uncovered, then scant, feeble grass, which as we proceed becomes richer and taller. At 20 miles we see a few acacia scrubs dotting the plain every 400 yards or so, then a very thin, straggling group, which in a day's march you see deepened into a shady forest. At 30 miles you enter under the impervious umbrage of a tropic forest, which grows darker and taller, and presently impenetrable, and for 30 miles you are among the marvels of vegetable life; then you emerge among the acacias again, and 12 miles from Lake Albert Edward they disappear altogether, and you see nought but grass, decreasing in height, losing succulency, feeble and scant, until you are on the saline mud of the shore of the Upper Lake.

I hope now that you perceive that I am only suggesting. I by no means assert anything except what we saw and know from observation. If the south end of Lake Albert is 1° 10′ N. lat. now, in 1864, when Sir Samuel Baker discovered it, the south end was in N. lat. 1° 7′, in the natal year of his Royal Highness the Prince of Wales it was at N. lat. 1° 4′ 30″. Five years after Charles I. began to reign the south end was in N. lat. 0° 40′ 0″. During the siege of Troy the two lakes were one, and the south end of the great lake was in 1° 10′ S. lat., and if these two lakes wear away their obstructions as they have been doing, in the year 2150 there will be no Lake Albert Edward, and in the year 2540 the Lake Albert will have vanished, and the Semliki Valley will have extended its length to 2° N., and the Semliki River will have united the Victoria Nile to form the Bahr el Abiad, or White Nile.

THE MOUNTAINS OF THE MOON.

Do you know that I hesitated to mention the discovery of the Mountains of the Moon as much as you would confess to have seen the famous sea serpent? I was quite prepared to hear some one ready to heap ridicule on the statement, but I have since been able to fortify the assertion by inspecting the maps of the ancients—Greeks and Arabs. That they were not explored long ago is due solely to the vagaries of individual cartographers. Why, as long ago as Homer the Mountains of the Moon and the fountains of the Nile and the pygmies had been heard of and located with excellent judgment, but Hekatæus, Hipparchus, Ptolemy Idrisi, the Portuguese, Dutch, and French cartographers, shifted these interesting features of African geography whither they listed. From 10 deg. north of the equator they shifted the Mountains of the Moon to 20 deg south, and then 10 deg. nearer, then to the neighborhood of the line, then with a flying leap to 10 deg. north of it; they caused the old continent to assume an exceedingly dissipated appearance in the 16th century, and in the 17th they gave it a penitent shore line, but the crime of crimes was perpetrated in the twenties of this century, when D'Auville, a Frenchman, and Murray, a Scotchman, conspired to rob Central Africa of the three lakes which had played such a part on past maps, and to draw the Mountains of the Moon as extending from the Gulf of Guinea to the Gulf of Aden. You need not wonder that during the last forty years you have heard travelers indulging in intemperate language whenever the Mountains of the Moon were mentioned.

Listen to this beautiful legend, which I obtained while I was at Cairo, among many others. It is taken from a book with the taking title of "The Explorer's Desire."

"There is a difference of opinion as to the derivation of the word 'Gumr.' Some say that it ought to be pronounced Kamar, which means the moon. Hence Jebel Gumr—the Mountains of the Moon; but the traveler Ti Tarshi says that it was called by that name because the eye is dazzled by the great brightness. This mountain, the Gumr, extends eastward and westward into uninhabited territory on both sides. Indeed, this whole chain is uninhabited on the southern slope. This chain has peaks rising up into the air, and other peaks lower. Some have said that certain people have reached these mountains and ascended them, and looked over to the other side, where they saw a sea with troubled waters dark as night (Lake Albert Edward, of course), this sea being traversed by a white stream bright as day, which enters the mountains from the north and passes by the grave of the great Hermes; and Hermes is the prophet Idrisi or Enoch.

"It is said that Enoch there built a dome. Some say that people have ascended the mountain, and that one of them began to laugh and clap his hands, and throw himself down on the further side of the mountain. The others were afraid of being seized with the same fit, and so came back. It is said that those who saw it saw bright snows like white silver glistening with light. Whoever looked at them became attracted, and stuck to them until they died, and this science is called 'Human magnetism.'

"Adam bequeathed the Nile unto Seth, his son, and it remained in the possession of these children of prophecy and of religion, and they came down to Egypt (or Cairo), and it was then called Lul, so they came and dwelt upon the mountains. After them came a son called Kuiaan, then his son Mahaleel, and then his son Yaoud, and then his son Hamu and his son Hermes—that is, Idrisi or Enoch the prophet. Idrisi it was who reduced the land to law and order. He then went to the land of Abyssinia and Nubia and gathered the people together and extended the distance of the flow of the Nile, or reduced it according to the swiftness or sluggishness of the stream.

"It is said that in the days of Am Kaam, one of the kings of Egypt, Idrisi was taken up to heaven, and he prophesied the coming of the flood, so he remained on the other side of the equator and there built a palace on the slopes of Mount Gumr. He built it of copper, and made eighty-five statues of copper, the waters of the Nile flowing out through the mouths of these statues, and then flowing into a great lake, and thence to Egypt.

"Idyar el Wadi says the length of the Nile is two months' journey through Moslem territory and four months' journey in uninhabited country; that its source is from Mount Gumr beyond the equator, and that it flows to the light coming out of the River of Darkness, and flows by the base of Mount Gumr."

There is no need for me to tell you that Jebel Gumr is Ruwenzori—the Cloud King; that the sea of Darkness is the Albert Edward Nyanza, and that the River of Darkness is henceforth to be known as the Semliki, which empties into Lake Albert, and that from the latter lake issues the White Nile, which, near Khartoum, joins the Blue Nile. (Loud cheers.)

Another emotion is that inspired by the thought that in one of the darkest corners of the earth, shrouded by perpetual mist, brooding under the eternal storm clouds, surrounded by darkness and mystery, there has been hidden to this day a giant among mountains, the melting snow of whose tops has been for some fifty centuries most vital to the peoples of Egypt.

Imagine to what a god the reverently inclined primal nations would have exalted this mountain, which from such a far-away region as this contributed so copiously to their beneficent and sacred Nile. And this thought of the beneficent Nile brings on another.

In fancy we look down along that crooked silver vein to where it disports and spreads out to infuse new life to Egypt near the Pyramids, some 4,000 miles away, where we beheld populous swarms of men—Arabs, Copts, fellahs, negroes, Turks, Greeks, Italians, Frenchmen, English, Germans, and Americans—bustling, jostling, or lounging, and we feel a pardonable pride in being able to inform them for the first time that much of the sweet water they drink, and whose virtues they so often exalt, issues from the deep and extensive snow beds of Ruwenzori or Ruwenjura—"the Cloud King."

LAKE ALBERT EDWARD.

We have thus traveled along the north, the northwest, and eastern coasts of Lake Albert Edward. The south side of the lake, much of which we have viewed from commanding heights, such as Kitete, is of the same character as the flat plains of Usongora, and extends between 20 and 30 miles to the base of the uplands of Mpororo and Usongora. Kakuri's canoe men have been frequently voyagers to the various ports belonging to Ruanda and to the western countries and all around the lake, and they inform me that the shores are very flat, more extensive to the south than even to the north, and more to the west than to the east. No rivers of any great importance feed the Albert Edward Lake though there are several which are from 20 ft. to 50 ft. wide and 2 ft. deep. The largest is said to be the Mpanga and the Nsongi. This being so, the most important river from the south cannot have a winding course of more than 60 miles, so that the furthest reach of the Albertine sources of the Nile cannot extend further than 1° 10′ south latitude.

Our first view, as well as the last, of Lake Albert Edward was utterly unlike any view we ever had before of land or water of a new region. For all other virgin scenes were seen through a more or less clear atmosphere, and we saw the various effects of sunshine, and were delighted with the charms which distance lends. On this, however, we gazed through fluffy, slightly waving strata of vapors of unknown depth, and through this thick opaque veil the lake appeared like dusty quicksilver, or a sheet of lusterless silver, bounded by vague, shadowy outlines of a tawny-faced land. It was most unsatisfying in every way. We could neither define distance, form, or figure, estimate height of land crests above the water, or depth of lake; we could ascribe no just limit to the extent of the expanse, nor venture to say whether it was an inland ocean or a shallow pond. The haze, or rather cloud, hung over it like a gray pall. We sighed for rain to clear the atmosphere, and the rain fell; but, instead of thickened haze, there came a fog as dark as that which distracts London on a November day.

In brief words, the northwest and west sides of Ruwenzori, blessed with almost daily rains and with ever fresh dews, enjoy perpetual spring and are robed in eternal verdure, the south and southwest sides have their well defined seasons of rain and drought, and if seen during the dry season, no greater contrast can be imagined than these opposing views of nature's youth and nature's decay.

But alas! alas! In vain we turn our yearning eyes and longing looks in their direction. The Mountains of the Moon lay ever slumbering in their cloudy tents, and the lake which gave birth to the Albertine Nile remained ever brooding under the impenetrable and lovely less mist.

THE ADVANTAGES OF THE EXPEDITION.

The question has been asked by stolid and thoughtless people, What good has been derived from our late expedition, which less than a year ago was about commencing its long march to the sea from Lake Albert? And I answer that to humanity the gain has been great. The world is richer by the knowledge that there are 10,000,000,000 more trees in it than we knew of before; that there are exhaustless quantities of rubber and gums and dyestuffs; that there is navigation furnished by nature by which those interested in those treasures can proceed to collect them; and that by those vegetable products the millions of degraded human beings within that great forest will, in process of time, learn that their fellow creatures have far vaster value than the value of their flesh.

As a Christian nation you should rejoice that the few thousand pounds you lent for this service rescued over four hundred men, women, and children from slavery; that you restored 290 people to their homes in Egypt; that you restored the late governor, stagnating among the impossibilities, to active service for a friendly nation, and a gallant captain and explorer to his countrymen of Italy, and a merchant Greek to his family; and I am quite sure that you begrudge your bounty as little as we our service. Thirdly, as geographers you must be gratified with the wide extension of geographical knowledge gained. The Aruwimi River is known almost throughout its entire length; you know the extent of that immense forest, you know the connecting link of water between the two lakes along the course of the Albertine Nile, the classic river, the source of which, Alexander, Cambyses, Cæsar, and Nero desired to know—you now know to its very fountain head; those lofty Mountains of the Moon which have been so anxiously sought for since Homer's time, have now been surveyed and located; the most glorious portions of inner Africa have been traversed and described for the first time; and we know now that there is scarcely an acre throughout the area but is a decided gain to our earth; and I assert that every mile of new lands traversed by us will serve in the coming time to expand British commerce and stimulate civilized industry; and, finally, we have extended British possessions to the eastern limits of the Congo Free State, having acquired many thousand square miles of territory for the assistance by force of arms and other considerations against their enemies the Wara Sura.

Our promise had been on setting out on this expedition to do as little harm and as much good as possible. We, therefore, submit these bare outlines of our service, hoping that they will be acceptable to you.

Mr. Stanley resumed his seat amid prolonged cheering.

The Prince of Wales: Ladies and Gentlemen—By the permission of your president a task has been laid upon me which is both easy and difficult. It is an easy one, inasmuch as I shall have the pleasure to propose to you a hearty vote of thanks to Mr. Stanley for the interesting address which he has given us to-night. (Cheers.) I feel that the duty might have been placed in worthier hands of proposing this vote of thanks. We have all listened with profound attention and interest to the address which has fallen from Mr. Stanley. It is marvelous to me that in so short a space of time he was able to give us so much valuable and interesting information. (Cheers.) His name must ever go down to posterity as one of our great travelers, and I may say philanthropists, and one whom the Royal Geographical Society will ever be proud to have honored. (Cheers.) I may remind you that it is fifteen years ago since, under the auspices of the *New York Herald*, Mr. Stanley went out to look for the great traveler, Livingstone, and succeeded in finding him. He discovered the Congo, which has now become a great State, and last, not least, he was sent by some philanthropic gentlemen to try and find, and if possible release one of the ever-to-be-regretted Gordon's lieutenants, Emin Pasha. (Cheers.) You have heard from him to-night, and I have also had opportunities of hearing from him on other occasions the terrible difficulties he had to undergo in achieving his last object. He has told you of the great equatorial and almost impenetrable forests, 621 miles in length. He has told you also of that wonderful race of pygmies who have existed for fifty centuries, and who have been more instrumental in lengthening his journeys than any other cause. He has also told you in a very interesting manner of the actual position of the Mountains of the Moon, which have been described by the ancients and placed in various positions. I cannot claim a right to address you in any way as a geographer. At the same time it affords me the most sincere satisfaction to discharge the task laid upon me, however imperfectly it may be carried out. I ask you most cordially not only to give a most hearty and unanimous expression of thanks and gratitude for the admirable and interesting address we have heard to-night, but also to extend to Mr. Stanley a hearty welcome on his return after his long and arduous journeys, and to give a like welcome to those brave and distinguished gentlemen whom I see here to-night, and who were the companions of his travels. (Loud cheers.)

The Duke of Edinburgh, in seconding the motion, said: I am sure that if the Prince of Wales found himself in some difficulty in proposing this vote of thanks, I feel a much greater difficulty in seconding the vote, because in his speech the Prince of Wales touched on

so many of the points of interest in Mr. Stanley's address that it is not easy to say anything fresh. On the occasion when we first had the pleasure of hearing Mr. Stanley—in the St. James' Hall—he gave us a description of his work as in connection with the Relief Committee which sent him out; here, however, he has given us information more directly connected with the society which has gathered us together this evening. His description of the forest through which he traveled was most impressive, and the climate in that region seems to be one which one would not prefer to the London fog alluded to by Mr. Stanley. (Laughter.) The great value of the information which has been conveyed to us this evening lies in the fact that it makes possible the completion of the map across the whole of the continent—a map which has been so grievously distorted in previous times. I have no other words to add in seconding the vote of thanks, except to express my own most cordial welcome to Mr. Stanley and his colleagues on their return to this country. (Loud cheers.)

The President then put the vote of thanks formally to the meeting, and it was accorded with great enthusiasm.

The President: In 1873 the Royal Geographical Society assigned its gold medal to Mr. Stanley. By doing that it exhausted all its ordinary power of honorific distinction. But the council of the society has come to the conclusion that Mr. Stanley has done so very much more since that time than he did before, that they felt it was their duty to assign to him another medal for what he has done up to this time. (Cheers.) Mr. Stanley would not have wished, and we should not have wished, that that honor should appertain only to him. Accordingly, we have awarded medals to all his gallant companions. (Cheers.) Mr. Stanley's medal is made of British gold, which has been given for this express purpose by Mr. Pritchard Morgan, who desired thereby to show his admiration for Mr. Stanley's achievements. (Cheers.) We have also thought it right to assign marks of honor to the Zanzibaris and others who accompanied Mr. Stanley. (Cheers.) The distinction to be assigned to them is to take the form of a silver star. I have now to request his Royal Highness the Prince of Wales to be so good as to present the medals to Mr. Stanley and his companions.

The Prince of Wales, addressing Mr. Stanley, said: Mr. Stanley, it affords me great pleasure to present to you this medal. (Loud cheers.) I am very glad indeed that it has fallen to my lot to do so (Renewed cheers.)

Mr. Stanley, taking the medal, bowed and sat down.

The Prince then presented the medals to Captain Stairs, Dr. Parke, Captain Nelson, Mr. Mounteney Jephson, and Mr. Bonny, amid loud cheers for each recipient.

Mr. Stanley then arose and said: Mr. President, your Royal Highness: It has been said that no great work was ever done through hate, that neither was it done through ire, but that it has been done through love, and you will have to accept what I have done as being done solely through love of the work I was appointed to perform. (Cheers.) It was a former president of this society that sent Dr. Livingstone on his last fateful journey before he died. I spent four months and four days with him, and I had the pleasure of hearing a great many things about this society for the first time in my life. Among many other things of which he had a keen recollection were the gorgeous feasts which sometimes the Geographical Society gives to its explorers. (Laughter.) He did not tell me much about the medals. I have seen the medals since I have returned, and to-day I have got the grandest and biggest and noblest of them all (cheers), and it has been presented by his Royal Highness the Prince of Wales to me, which makes it an additional honor; and you gathered here this evening to welcome me after this last journey—you have enhanced its value by impressing more vividly on my memory what a grand galaxy of beauty and talent has been gathered here this evening. I beg you to accept my best thanks, and, if my companions will permit me, to thank you in their name also. (Cheers.)

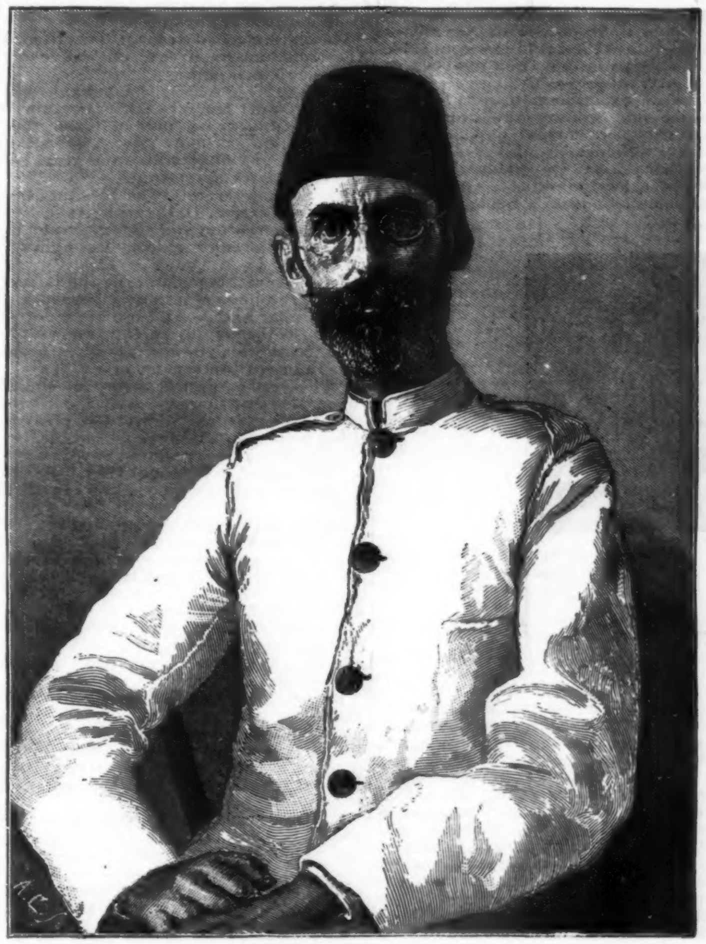
The President: You will all, I am sure, desire that I should express the thanks of the Royal Geographical Society and of all who are here present to our honorary president and vice-president for having come here to-night and taken part in these proceedings. (Cheers.) This meeting is now adjourned.

When the great audience had thus been dismissed in the usual formal way by the president's announcement, the Princess of Wales came on the platform and graciously shook Mr. Stanley's hand, as did also the Prince, the Duke of Edinburgh, the Duke of Cambridge, and the other members of the royal family present. Outside the Albert Hall there was a crowd of several thousands, who had been waiting for several hours to see the gathering disperse.

For the foregoing report we are indebted to the *London Times*, and for our engraving of the scene in Albert Hall to the *Graphic*.

EMIN PASHA.

HAVING given full biographical details concerning the governor of the Equatorial Province, such information need not be repeated here. It is more apposite to observe that an expedition which was carried to a successful issue by the courage and patience of its leaders, despite unparalleled hardships and privations, after all rescued a man who was by no means anxious to be rescued. People who read the wonderful narrative hastily are apt to forget that about nine months elapsed between the two meetings with Emin Pasha. The first took place on April 29, 1888. As Emin then showed no keen desire to give up his post, Stanley departed to search for his rear column, and, having reorganized his scattered forces, returned to the Albert Nyanza. Emin's position had completely changed in the interval—his officers had revolted against him, and he had been for a time a prisoner. Yet even then Stanley had hard work to persuade him to quit the disaffected province. At length, on April 10, 1889, the homeward march began to the east coast, and Bagamoyo, a coast village opposite the island of Zanzibar, was reached on December 4. A banquet was given in the evening by the German officers to welcome the explorers. It was followed by a sad disaster, for Emin, who is near-sighted, walked out of a window and fractured his skull. For a long time he lay in a precarious state, but, under the untiring care of Surgeon Parke, he made a wonderful recovery. Our portrait is from a photograph recently taken at Zanzibar, and kindly sent to us by Dr. R. W. Felkin, F.R.G.S., F.R.S.E.—*The Graphic.*



EMIN PASHA.

(From a photograph taken after his arrival at Zanzibar.)

THE PHYLLOXERA PROBLEM.

THE report of the Superior Phylloxera Commission has just been published, and gives the latest account of phylloxera matters in France and other foreign countries. Neither law nor effort has prevented the spread of the insect in eleven *arrondissements* in which it made its appearance for the first time the past year, viz.: Castellane, Mende, Riom, Joigny, Troyes, Nogent-sur-Seine, Bar-sur-Aube, Vesoul, Gray, Bonneville, and St. Calais. About 240,000 acres have undergone defensive measures, submersion being employed in 72,000, bisulphide of carbon in 145,000, and sulpho-carbonate of potassium in 23,000.

Much good has resulted from the establishment of societies for defense, notably in Haute-Loire. Moreover, it is the small proprietor who derives the largest benefit from the law enacted August 2, 1879. Of twenty-one thousand three hundred and ninety-four proprietors composing a syndicate, each attended to about 4½ acres.

The departments in which vine cultivation is extensive, such as Herault, Gard, and Gironde, contain fewer syndicates for the reason that their phylloxera work is practically at an end. Each year has shown an increasing acreage of reconstituted vineyards, mostly by means of American stocks, which prove more and more satisfactory, and which justify the commission in prophesying the near approach of the time when vine culture will be as widespread as it was before the era of the phylloxera. The following approximate tabular statement will be interesting in this connection:

Years.	American vines covered.	Departments.
	Acres.	
1881	22,000	17
1882	42,700	22
1883	70,000	28
1884	131,909	34
1885	188,900	34
1886	276,900	37
1887	418,700	38
1888	536,900	43
1889	719,500	44

If the march of recovery continues at this ratio, in four years vine-planted land in France will reach the unprecedented amount of 6,500,000 acres. Herault presents 380,000 acres of renewed vineyards, Aude 68,000, Gard 60,000, Gironde 47,000, the western Pyrenees, 75,000, and Var 47,000.

The efforts to produce by hybridization phylloxera-proof varieties have so far not proved successful or popular, as most growers still depend on grafting on the American stock. Another noticeable fact is that government does not hesitate in its liberal policy of doing all in its power to aid the afflicted vine grower, and the law of December 1, 1887, by which the land tax on newly planted or restored vineyards is remitted for four years, is still in force.

Five years ago the phylloxera first became known in Algeria, and since then it has been kept pretty well in check by the vigorous measures prescribed by the resolution adopted March 21, 1883. The cost has been great, but the results have fully justified the outlay. The vine there covers nearly 250,000 acres, and the vintage of 1889 shows approximately 66,000,000 gallons of wine.

A glance at the viticulture of other vine-growing countries shows that the industry is rapidly developing, especially in Chili, Uruguay, the Argentine Republic, and Australia. The Tunisian vineyards present remarkable development.

Spain and Italy are yet suffering severely from phylloxera. In the former the small proprietors are reduced to the necessity of abandoning the cultivation of their fields or selling them at much depreciated prices. The emigration from Malaga to Brazil and the Argentine Republic between April and August, 1889, amounted to eleven thousand persons, and may be taken as an index of the situation.

In Italy about 400,000 acres are affected, and the government has been forced to forego its first system of defense and resort to American stocks.

Hungary suffers sorely. About one-third of its plantations are attacked and about one-eighth destroyed.

Austria suffers in almost like proportion.

In Switzerland the progress of the phylloxera has been slow, and in Germany and Russia, owing to the measures taken for its suppression, it makes no progress.

Portugal seems to be in the worst plight of all, for each year the number of invaded districts increases, chiefly in the north, where there are 250,000 acres of infested vines and 90,000 acres of dead ones. The Douro region aggregates 80,000 dead vines out of a possible 125,000.

Nowhere has the combat been carried on more energetically than in France, originally the most sorely stricken country, and nowhere has so much success been achieved against phylloxera attack.—*Insect Life.*

SOLUBILITY OF GLASS IN WATER.

MYLIUS and Foerster very carefully examined the solubility in hot and cold water of a large variety of glasses, and came to the following conclusions, which are given in the *Journal of the Chemical Society:*

(1) Water-glass is decomposed by water into free alkali and silicic acid, a certain proportion (varying with the time of action, concentration and temperature) of the latter becoming hydrated and dissolved.

(2) Potash glasses are far less soluble than soda glasses, but the difference decreases with increase of the proportion of lime present.

(3) Soda and potash are united in glass both to the silica and the lime. The resistance of glass toward the action of water is dependent on the presence of double silicates of soda or potash and lime.

(4) Of all sorts of glass, the plumbiferous flint glasses are least soluble in boiling water.

(5) The relative resistance of glasses is different toward hot and cold water.

DESCENDING WINDS.

IN order to explain the slow progress of meteorology, it has often been repeated that the meteorologist finds himself face to face with nature in a forcedly passive state. While his confreres, the chemists and physicists, can, at will, vary the conditions of their experiments, and repeat them as many times as they please, the meteorologist, reduced to the role of a vigilant sentinel, must await the return of a phenomenon that he perhaps may never see. This is true, and, although the great laboratory of nature is open to all, no one has the right to command it, and the most privileged must be content to observe what takes place therein.

However, it would be going too far to assert that the meteorologist is absolutely destitute of the means of

FIG. 1.—DESCENDING WIND.

making experiments. In fact, he is often placed in such a situation for want of instruments, so, when he wishes to make experiments, he often has to set his wits to work to find a means of performing them with the commonest objects. Such is the case with the curious experiments of Mr. Piche, the inventor of a well known evaporometer.

Struck by the fact that certain winds seem to follow the declivity of mountains and descend into the valleys, this scientist has looked into the cause of this curious and surprising phenomenon, since, the wind not being very weighty, it would seem more natural that it should, with one bound, transport itself from one summit to another, leaving the valleys untouched instead of following the descending as well as ascending declivities, like a vulgar pedestrian, whose weight attaches him to the earth.

Mr. Piche believed the phenomenon to be a consequence of the viscosity of the air, which makes the latter adhere to solid bodies, as water adheres to the objects that it wets. Such adherence of the air to solid objects is, moreover, well known, and it serves as a basis for several parlor experiments, one of the best known of which is the raft of steel. In order to perform this experiment, it suffices, as well known, to place upon a glass of water a piece of cigarette paper carrying a certain number of very clean and very dry sewing needles. In a few moments the paper will have absorbed water and sunk to the bottom, leaving the needles swimming on the surface. We thus have a raft of steel recalling a raft of floating wood. The density of steel is nearly eight times greater than that of water, and how does it come, then, that the needles do not fall to the bottom of the glass? It is because a sort of atmosphere adheres to each of them, a small pellicle of air, which, so to speak, becomes part of the steel and diminishes the density of the whole. So, although each needle is heavier than the water, the needles collectively are not so heavy, and, therefore, float.

This viscosity of the air readily explains another parlor experiment which might well have been the starting point of Mr. Piche's researches. A candle is placed behind a bottle. Upon blowing strongly with the mouth from the opposite side, the air reaches the flame and easily extinguishes it. It thus appears as if the flame were extinguished by blowing through the bottle. Fig. 4 shows this experiment. A diagram at the bottom shows what occurs. The air adherent to the bottle passes around the latter on each side and unites in a single current, which acts upon the flame of the candle.

We can now reproduce Mr. Piche's curious experiments, which require nothing but objects that one has usually at hand. As a source of wind we shall use the double rubber bulb which enters into the construction of a host of apparatus in daily use, and especially of vaporizers; we may even use a vaporizer without any change, provided that it contains no liquid. The

the thread inside the cardboard arch will make the system stable. Then, upon operating as shown in the figure, we shall see that the flame of the candle will not be reached unless it is held beneath the arch. The experiment will succeed with any sort of smooth object—bound book, work box, etc. The current of air is inflected according to the contours of the body with a polished surface.

But it will no longer be the same if the surface is rough, like that of a sponge or brush. Fig. 2 represents such a case and needs no explanation. It will be seen that the current of air, instead of following the profile of the brush, ascends, and the candle is reached only when it is held at a certain height above the table. In other words, the current of air, instead of following the contours of the object, rises and takes a direction nearly at right angles with the normal. When a vaporizer

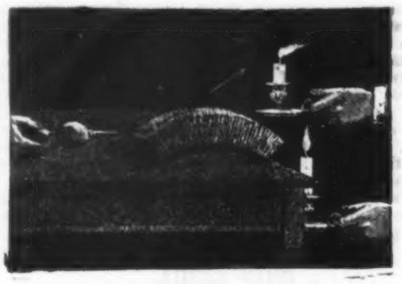


FIG. 2.—ASCENDING WIND.

is used, a few drops of hydrochloric acid and ammonia may be put into it. There will then be produced, with the current of air, clouds of hydrochlorate of ammonia, which will permit of easily following the current's course by rendering it visible. This variant of the experiment is most interesting, and we could not recommend it too strongly had it not the drawback of affecting the sense of smell disagreeably.

Such is the result of the experiment made under as modest conditions as possible, but not out of proportion with the action of nature. Our current of air is, it is true, hundreds and even thousands of times feebler than the currents that sweep the mountains and plains, but these none the less follow the same laws. For them, however, a small stone or a blade of grass

FIG. 4.

is an insignificant asperity. Bare or simply grass-covered ground is smooth, as regards the circulation of winds, and nothing but ground covered with forests is to be considered as rough.

This granted, it is easy to understand what occurs when the wind sweeps over a denuded mountain (Fig. 3). We then have the case of a smooth surface, and the wind, following the declivities of the earth, will blow into the valley in the form of a plunging current.

If, on the contrary, it passes over a mountain covered with fir trees, the general current will rise and the valley will be completely sheltered.

It will be seen that there is here an important character to be added to all that has already been written upon the question of the *reboisement* of mountains.

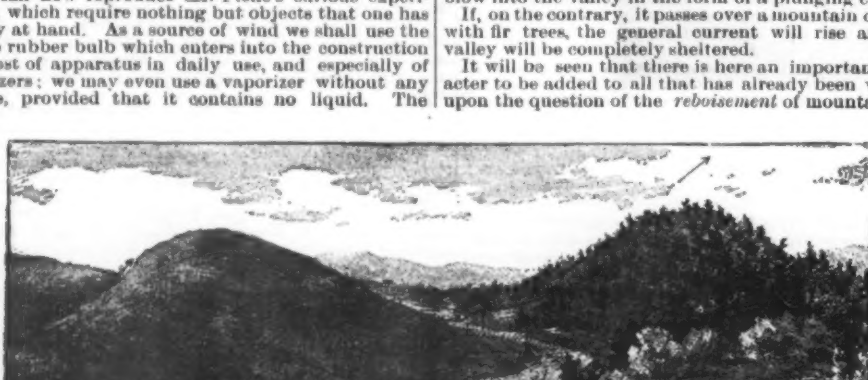


FIG. 3.—INFLUENCE OF WOODED AND BARE SURFACES UPON THE DIRECTION OF THE WIND.

mountain will be formed of a sheet of Bristol board kept curved by means of a thread or cord. If a cord be used, it may be simply passed around the cardboard (Fig. 1); if a thread be used, it can, by means of a needle, be passed through the cardboard so as to give an absolutely free surface above. A book placed upon

A certain number of experiments made by scientific men have shown that Mr. Piche's theory is justified in a large number of cases. It would be interesting to verify it everywhere where it is possible. From such an examination, perhaps some new fact might be brought out that would permit of completing one of

the rare meteorological theories based upon cabinet experiments.

At all events, whatever be the issue of it, it is here a question of those easy observations that demand neither transcendent science nor costly instruments. The only thing necessary is willingness and conscientious discernment. It may be said that Mr. Piche has opened up new horizons and has proved that experimentation does not completely escape meteorologists.—*Cosmos.*

SUNHEAT AND SUNLIGHT.

By HENRY RAYMOND ROGERS, M.D., Dunkirk, N. Y.

[Read before the Chautauqua Society of History and Natural Science.]

IN every age since the birth of science the profoundest philosophic minds have endeavored to solve the problem of the sun, yet, hitherto, all efforts have proved fruitless, and to-day the riddle of the sun remains unread.

It has ever been the popular idea that the sun is actually a vast and dazzling ball of fire placed in the heavens to heat and light the earth, and the present scientific theory is not found in advance of this popular notion.

The highest conception which scientists now entertain in regard to the essential nature and constitution of the sun is that it is a vast mass of incandescent vapors or gases; and science still continues to account for all the sun's phenomena upon this *fireball* hypothesis.

Among the opinions recently expressed by some of the most eminent investigators of solar phenomena are found the following. Secchi, the late distinguished head of the Roman Observatory, says:

"For me, as for every one else, the sun is an incandescent body raised to an enormous temperature."

Mr. Lockyer, of the Royal Society of England, an authority distinguished in this field, says:

"We are enabled to state as a proved fact that the light of the sun proceeds from particles in a state of incandescence or glowing heat."

The distinguished German authorities, Kirchhoff and Angstrom, imagined the sun and every star in the heavens to be liquid.

The late Mr. Proctor, of London, says:

"The planet Mercury, 37,000,000 miles from the sun, in an incandescent, molten mass. Venus, 64,000,000 miles distant, is more favorably situated; yet, undoubtedly, it will be millions of years before it will be cool enough for habitation."

Mr. Langley, secretary of the Smithsonian Institution, Washington, D. C., says:

"All observation and all legitimate inference go to show that the sun is gaseous throughout."

Professor C. A. Young says:

"The central portion of the sun is probably for the most part a mass of intensely heated gases. The outflow of solar heat is at least seven or eight times as intense as that of any furnace known to art."

Mr. Newcomb, the distinguished astronomer of the Washington Observatory, says:

"The best sustained theory of the interior of the sun is the startling one that it is neither solid nor liquid, but gaseous; so that our great luminary is nothing more than an immense bubble."

Another eminent scientist says:

"There can be no doubt that if the sun were to come as near us as the moon, the solid earth would melt like wax."

All the authorities thus quoted are authors of recent and standard works in this field. As these expressions of scientific opinion are strictly in accordance with the sentiment of scientific bodies, both at home and abroad, they must stand as statements of current scientific opinion on this subject.

Science is thus fully committed to the so-called *fireball* philosophy of the sun. Hitherto it has asserted no other, and to-day it makes no pretense of offering any other.

Indeed, scientists of the present time are pleased to represent that stupendous body, the sun, as being merely a *mechanical contrivance* for supplying *only the earth* with requisite heat and light. The incompetency of this philosophy is strikingly manifest in the utter failure to provide for the necessities of the whole solar family besides.

Mercury and Venus, according to its own representation, are too near the sun, and, consequently, too hot for sustaining life, while the outer and grander planets, Jupiter, Saturn, etc., are too cold for habitation.

It is a fatal defect in the system that it makes no general provision for heating and lighting all the planets alike. And, moreover, that such a sun, a million and a quarter times larger than the earth, should be set as a furnace specially to heat this little earth, and as a lamp for giving it light, is such a disproportion of means to an end that it implies a reflection upon the great architect of the universe for employing so vast a means for the accomplishment of so comparatively insignificant a purpose.

Still more strikingly apparent becomes the fallacy of the present *fireball* philosophy when it teaches, as it does, that the earth is the *only* member of our solar family—the sun itself included—which is capable of sustaining life in any of its varied forms.

The sun and earth are stars which differ only in magnitude. It is therefore the most unwarranted assumption to claim that of these two stars the comparatively insignificant earth alone is the abode of life, intelligence, and beauty. Such an assumption is as absurd as it is irrational.

Since science thus unequivocally asserts, as a great cosmical principle, that the sun is incandescent and of dazzling brilliancy, and that it "radiates" *actual* heat and light in all directions and to all distances into space, it should be capable of sustaining such conclusions by exact and satisfactory data. Nothing less than positive demonstration will satisfy the demands upon a theory so vast in its import and so fundamental in its character.

But science has utterly and totally failed to demonstrate its theories to be true. It has drawn its conclusions from sources which are purely hypothetical and mythical, sources, too, which are demonstrably as baseless as the fabric of a dream. These sources consist mainly of ancient traditions, superficial appearances, total eclipses, the so-called sun spots, and th nebular hypothesis.

Old traditional dogmas which are confessed worthless as data in science have had a controlling influence in moulding men's minds in this as well as in other great fields of thought.

So firmly have philosophers and scientists been held by old fossilized traditions and superficial appearances, that they have ever ignored and disregarded some of the most exact teachings of nature, reason, analogy, and the fitness of things.

One of the first great object lessons in science which nature taught to man was through the mountain tops clad in everlasting snows. This fact is positive demonstration that the further we go in the direction of the sun (at least to the height of our atmosphere), the more intense becomes the cold, and inferentially it is proof that all space is inconceivably cold.

The temperature of space is variously estimated by advanced scientists at from hundreds to millions of degrees below zero. Between the sun and earth there are about 93,000,000 miles of such inconceivable coldness. In view of such a temperature of the great interstellar space, it would be regarded, in a court of justice, as an evidence of downright lunacy to affirm that heat passes, as heat, through so vast a distance and so cold a medium. Yet this is precisely what science affirms, and what is taught in our schools and universities to-day.

Brilliant and dazzling though the sun really appears, its brightness, like its heat, is but seeming. The same process which develops *sunheat* also develops *sunlight*. The source and mode of development of each being the same, consequently the law by which they are governed must be the same. Thus, it is now well known that light diminishes in the direction of the sun, in the same ratio that heat diminishes.* Captain Abney, of the Royal Society, London, found, upon measurement, that at the elevation of simply one and one half miles the light of the atmosphere was only from one tenth to one twentieth as great as on the surface of the earth. At a little over three miles the sun appears no brighter than the moon, and at four miles the sun's rays are no longer capable of producing the rainbow colors of the solar spectrum. At that elevation the spectroscope shows only the yellow, *and that too without lines.* Notwithstanding the foregoing facts possess a most vital significance, yet they are almost entirely ignored and disregarded by scientists to-day.

Brilliancy is not a quality inherent in the sun. The dazzling brilliancy of the sunlight, so far from being located at the sun itself, as is both the popular and scientific conception, is actually confined to the earth's very surface. Thus, the so-called sunheat and sunlight, so far as the sun itself is concerned, are but superficial appearances—mere optical illusions.

Is it not passing strange that the educators of to-day, who know full well the foregoing facts, should be compelled to teach this fireball philosophy of the sun? Yet this is what our educators are constrained to teach at the dictation of so-called science. To teach otherwise would be at their peril.

This old misguiding and obstructive theory of the sun being stripped of its deceptive guises, the way is now open for broader, higher, grander, and withal simpler views and explanations. In fact, nothing short of an entire new philosophy of the sun and of the universe can meet all reasonable requirements in this field. Such a new philosophy must accord to the sun all that royalty to which it is entitled both by reason of its commanding position among the celestial host and its marvelous works. It must be capable of explaining all physical phenomena upon the clearest and most exact cosmical principles, and be found in harmony with every law of matter, motion, or force. Such a philosophy is not difficult to frame.

Aristotle is justly termed the Father of Science. From his standpoint of 2,300 years ago he could discern the coming philosophy, and he then commenced its foundation. He held the conception that but a single force exists in nature, that every form and manifestation of force is simply a transmutation of the one great universal force. This unity or identity of all force, then intuitively perceived and boldly advanced, has waited until the present century for its demonstration and acceptance. Knowing full well that force is not self-existent entity, that it must, therefore, have its source in some pre-existent, ever-active cause, he therefore sought for a source adequate to every requirement in every field of activity. As the sum of his conclusions in this study he tells us: "All changes in the physical world may be reduced to motion. All terrestrial phenomena, every conceivable form of force, must be referable to the impulse of the motions of the heavenly spheres." In no other conceivable source may the universal force originate. These conceptions of Aristotle are clear, rational, and philosophical, and, to the thoughtful scientific mind, they should have all the weight of self-evidence; yet, in all the succeeding ages they have never been fully comprehended and practically applied. Only to-day are they found capable of entire and satisfactory explanation.

The great problem in science is, therefore, how can the motions of the sun and stars be transmuted into every form of motion, or force, both of worlds and atoms? A star moving in vacuous space can have, of itself, no power over another star; neither the sun over the earth.

The gravitative force which holds the sun and earth in their orbital relations may be supposed to be something stupendous, yet the sun, in and of itself alone, possesses not a feather's weight of this power. The law of conservation of force is supreme and unquestioned. This law teaches that the gravitative force and all other so-called sun forces are due to retroactions shared in by both sun and earth, each in the ratio of its mass. This law also teaches, and, too, quite as forcibly, that the sun is as dependent upon its satellites for its own indispensable supply of heat, light, and gravitative force, as they upon it. The question arises, through what power or agency do these celestial retroactions take place? There is a power already well known which is capable of meeting every requirement in this field. A concise history of such a power may be given.

Twenty-five hundred years ago a spirit, or soul, a vital essence, was revealed unto mankind, the like of which had never been distinctively known. This wonderful creation came unheralded, and first disclosed its presence in an obscure and mysterious manner. A something reached out of a piece of senseless mineral and seized upon objects and drew them unto itself—without visible agency. The superstitious and astonished beholders called this newly discovered something the "amber soul." This amber soul was not destined then and there to die. Heaven guided its advent and controls its destiny. Most significantly and fittingly the pen which first recorded its birth on the page of science was guided by a master hand, viz., that of the wisest man of the most learned and cultured nation of antiquity—Thales of Miletus, the wisest of the seven wise men of Greece.

Though thus originating in such an humble and obscure source, this mysterious creation, this wonderful something, is, to-day, the very soul of the universe. It is now recognized as the vital agent which pervades and controls all matter—it holds all celestial spheres in their orbits, and the atoms of which those spheres are constituted, in their proper relations to each other. Thus the "amber soul" of the period of Thales of Miletus has become the great one-force of Aristotle of 2,300 years ago, and the universal force of to-day. We call this all-pervasive entity, this marvel of force, electricity. Electricity, therefore, is the sole power, or agency, through which all inter or retro actions take place between the starry hosts.

What is this heaven-born creation, this soul of the universe? No man knows what it is essentially; it can be judged only by what it does. During the past half century our knowledge of electricity has made great advancement. On the scale of the laboratory and in the field, where it possesses such vast commercial value, its development has been phenomenal. In its grandest field, however, the field of the universe, we can to-day clearly discern its most wonderful promise, its highest triumphs.

Electricity is not a self-existent entity, it cannot exist without a cause. Whether developed on the scale of the universe, or of the atom, it must be the product of the same causes and subject to the same laws. Generically, it includes magnetism, and so far as experiment can show, electricity and magnetism are identical. The earth is a vast magnet, and the atmosphere is more magnetic than any known substance except iron, nickel, and cobalt. This terrestrial magnetic ball is thus *filled to repletion* with this stupendous force. If the strength of a magnet may be judged by its dimensions, what must be the amount of power contained in the earth, the sun, and all the starry dynamo magnets? When we contemplate this power we become astounded, staggered!

Not less significant is the power due to the mass and velocities of the celestial spheres. The power embodied in a mass in motion is estimated by multiplying its velocity in feet per minute by its weight in pounds. The earth contains 250,000,000,000 *cubic miles* of matter moving with the velocity of one thousand miles per hour on its axis and one thousand miles per minute in its orbit. Thus the whole universe is made up of inconceivable magnetic force, inconceivable masses, inconceivable velocities, incomprehensible powers!

It is reasonable to suppose that the 50,000,000 and more of celestial dynamo magnets are endued with such stupendous powers for actual use. As those powers cannot be exercised upon the empty space in which they move, therefore they must reach out to and include in their operations all their celestial neighbors. The existence of such an intimate relationship between the starry host—a veritable *unity of worlds*—is now capable of the simplest and clearest demonstration.

Though the sun and earth are separated by the distance of 93,000,000 miles, yet electrical currents traverse that immensity of space with as perfect facility as if those bodies stood side by side. The instantaneous and incessant action between sun, earth, and all the starry host is one of the most vital and fundamental principles in physical science. It may be regarded as the very key to all physical philosophy, since it opens up clear and enlarged views of the whole subject. Yet notwithstanding the fact that this principle has been repeatedly demonstrated and publicly announced, and, in fact, is a fundamental principle in gravity, it has been utterly ignored and disregarded as an element in the great cosmical problem. If proof of such intimate relationship between the heavenly spheres were needed, it may be found in the following facts:

In 1859, observers from widely different standpoints saw two bright spots simultaneously appear upon the surface of the sun; and simultaneously with their appearing, violent electrical effects were observed at the earth. In Norway a telegraph operator was stunned and his instrument set on fire; and operators were stunned in many other places. A train of fire followed Bain's electric pen in Boston, and self-regulating magnetic machines were disturbed over both continents. This is proof of actual and instantaneous electrical intercommunication.

In the northern regions, where the temperature of the surrounding atmosphere was far below zero, Dr. Scoresby converged the sun's rays to a focus by means of a lens made of ice, and set fire to combustibles, exploded gun powder, and melted lead. To prove that these sun rays are electrical, we have only to state the fact that by rendering electrical rays parallel, and sending them through a lens of ice, we produce the identical effects obtained by Dr. Scoresby with the rays of the sun.

The distinguished scientists Zantedeschi and Barlocci demonstrated that magnets both acquire and lose strength as their poles are relatively exposed to the direct rays of the sun; gaining strength, even more than doubling it, when the north pole is exposed and losing strength when the south pole is exposed. These effects were intensified by the use of a lens.

To produce these effects it is clear that the sun's rays must be electrical, or magnetic, as the sun could neither add to nor take from the power of the magnet except its rays were of a like character.

These experiments are invaluable to science as rare and exact data. They were misinterpreted by their authors when they attributed their results to the action of the sun's *light*, instead of its electrical currents.

The foregoing facts must be accepted as actual demonstration that there are incessant interactions between the sun and earth, and inferentially between all celestial spheres, and that such interactions are electrical, of electrical origin, and governed by electrical laws.

Distance as between the celestial spheres is thus practically annihilated, and consequently sunheat, sunlight, gravity, and chemical action must be developed, and act, precisely the same at Neptune, nearly 3,000,000,000 miles distant from the sun, as at the earth, only 93,000,000 miles distant.

That grand old master in science, Aristotle, has told us: "All terrestrial phenomena, every conceivable form of force, must be referable to the impulse of the motions of the heavenly spheres;" and a more recent and also a distinguished authority in this field, Wm. H. Preece, F.R.S., London's electrician, tells us: "All physical phenomena, without a single exception, may be traced to the mere transformation of the electrical energy."

Most fortunately for science, both of these assertions are now abundantly demonstrable. Since space and distance are practically annihilated, and electrical currents play freely to and fro between sun and earth and all celestial spheres, therefore these *missing links*, these fundamental factors in the problem of the universe, being supplied, its solution becomes simplified. It is merely a matter of the practical application of well established electrical principles.

The questions now arise: How can the motions of the sun and stars be transmuted into every form of motion, or force, both of worlds and atoms? and whence the source of the electrical supply for all demands of the universe?

The electrical laws which hold here on this earthly platform hold also throughout the universal domain. Our study of practical electricity has been the study in miniature of the grand operations of celestial spheres. It is a fundamental principle in electrical science that the rotation of bodies opposite to magnets induces circulating electric currents.

Upon this principle is constructed the dynamo-electric machine, with which we are now so familiar and which gives to us our electric light, heat, and power. This machine is constituted essentially of two parts—viz., 1st, a revolving armature; and 2d, stationary magnets.

An armature consists simply of a piece of soft iron wound around with very many turns of covered wire. This armature revolving with great velocity *near* to, but *not touching*, the magnets, develops electricity ready to be carried from the machine by wires, on its mission of light production and other work.

Guericke and Volta experimentally demonstrated that "every movement of one body *near* another disturbs and puts in motion the electric current in *both bodies.*"

Extending this law from the lesser, or terrestrial, to the grander, or celestial, field, the inference becomes legitimate that the heavenly spheres, whirling with inconceivable velocity in space, evolve between them electrical currents in great cosmical circuits—that the sun and earth (which stand practically "*near to*, but *not touching*, each other"), revolving with such inconceivable velocity, thus become actually vast dynamo-electric machines or batteries, through the action of which currents incessantly pass to and fro between those bodies. Inferentially this process is universal. Thus is verified that grand conception of Aristotle, viz., that the universal force has its *source in the motions of the celestial spheres.*

An important element in electro-dynamics is *resistance*. Heat, light, and power are developed through the agency of resistance to the passage of the electric current. The current developed by the dynamo-electric machine shows no evidence of its existence while its passage remains unobstructed. The machine itself and the conducting wires are dark and cold, but through the resistance offered by the "carbon point" and "platinum coil," its unseen powers are brought into manifestation. The electric currents incessantly coming from the sun, through the darkness and cold of space, find their first *resistance* in our atmosphere. This magnetic atmospheric mass thereby becomes awakened into heat, light, and power. The sun's current, like the current of the little dynamo machine, is invisible; gives no manifestation; passes through a space like electricity through wires. Without being itself hot, it develops heat in our atmosphere, and without being itself luminous, it develops light therein. *In this process is therefore demonstrably shown both* THE SOURCE AND MODE OF DEVELOPMENT OF SUNHEAT AND SUNLIGHT.

Thus, sunheat and sunlight are the results of an electric system which differs from the Edison and Brush patents only in the stupendousness of its scale.

We may no longer claim that the vast power of the sun resides in itself alone—that heat and light proceed forth from it in all directions, and to all distances, as from a great center. These questions are now virtually settled, and forever, through the law of conservation of force. This law stands as a demonstration of the fact that neither power nor influence can go out from the sun in *any* direction, through the instrumentality of force *inherent in itself*. It follows, therefore, that, so far as the sun alone is concerned, neither heat, light, nor gravity has even an existence. According to this law, all celestial bodies hold to one another the relation of *interdependence*. If, for example, sun heat is developed at a planet, both sun and planet must necessarily share in its production, each in the ratio of its mass. So also of light, gravity, etc.

The terms "radiation" and "emission," now so constantly employed by scientists as signifying the sending or throwing out of heat and light by an inherent propulsive power resident in the sun itself, are baseless, and therefore wholly misleading. The wastefulness implied in the current theory of universal radiation is altogether beyond computation, involving as it does the most prodigious and inconceivable squandering that science permits us to contemplate; even the complete destruction of cosmical equilibrium.

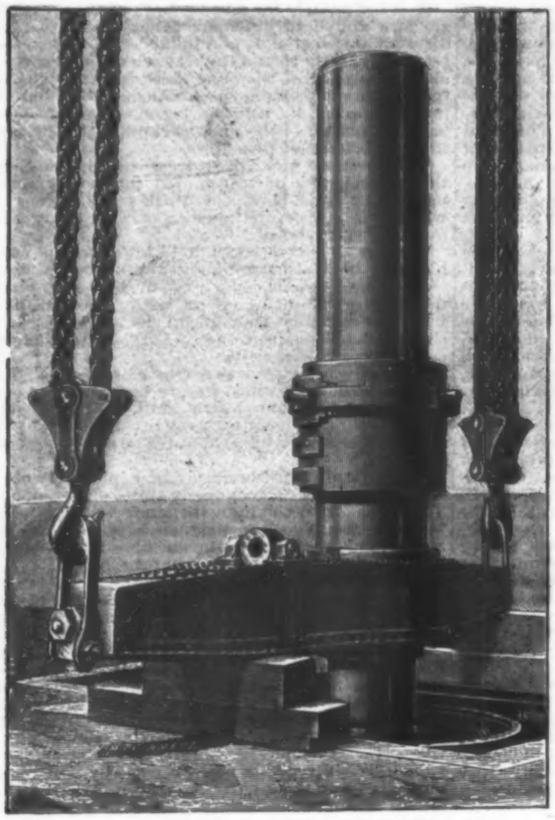
Any cosmical theory which involves waste stands already self-condemned, and should not for a moment be tolerated, yet, strangely enough, *actual dissipation, or waste*, is a fundamental element in every system of physical philosophy hitherto advanced.

Conservation is the very essence or soul of the electrical law. Electricity cannot move from atom to atom, or from world to world, except a return current of equal magnitude and power quickly follows. It cannot move except in a circuit. Herein is a perfect exemplification of the law of conservation. The electrical theory herein advanced is the only great cosmical theory which involves no waste. This theory will be found in entire harmony with every demonstrated law, or principle, or fact now known to science; *ergo the electrical theory* is the only rational theory of the universe.

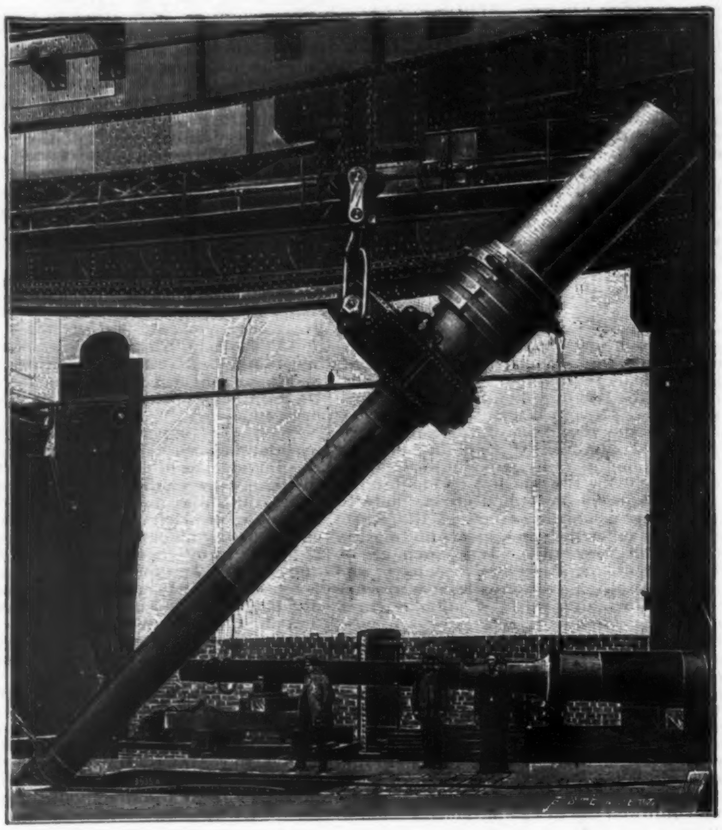
According to this theory, the sun may heat and light the earth, and still be a dark, cool, habitable body.

THE GUN FACTORY OF THE FORGES ET CHANTIERS DE LA MEDITERRANEE.

The Societe des Forges et Chantiers de la Mediterranee is the most important of the private naval establishments in France. The company possesses extensive shipbuilding works at La Seyne, close to Toulon; engine works at Marseilles, and at Havre another shipyard and engine works, while during the last few years an ordnance factory on a very extensive scale has been created there. No doubt this last addition to the company's works would have been brought into existence many years earlier, had it not been for the restrictive legislation which put a stop to all enterprise in France so far as the manufacture of war material was concerned; and until the company was set at liberty to produce ordnance themselves, they were placed in the unsatisfactory position of seeing ships that they had built for foreign customers armed with guns that had been purchased in England or elsewhere. As soon as the law permitted, the company set to work to alter this state of things, and they proceeded with the work in a manner that would have done credit to the most enterprising American spirit; they were, it is true, exceptionally fortunate in having as the chief of their ordnance works an engineer—M. Canet—who had been brought up in what was certainly one of the best possible schools, that of the Vavasseur Ordnance Company, since amalgamated with Sir William Armstrong & Co.

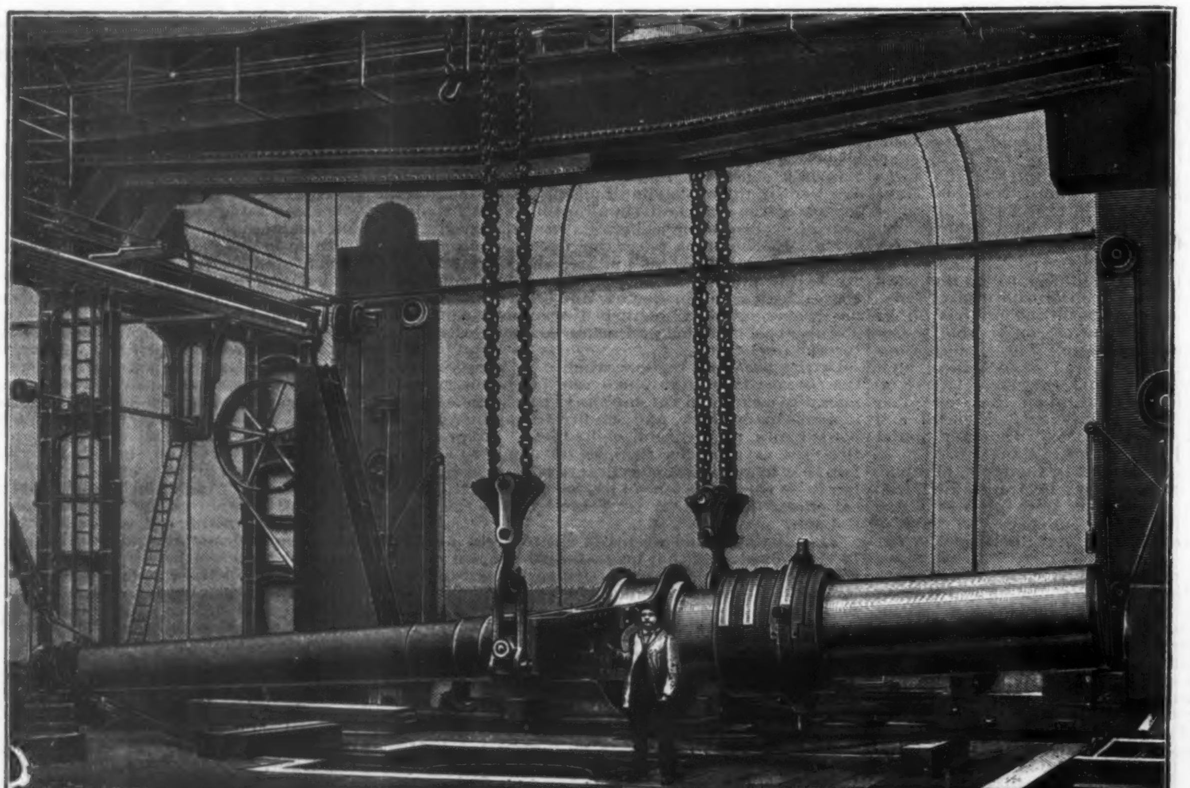


SHRINKING ON THE RINGS OF A 33 CENTIMETER GUN.



LIFTING 33 CENTIMETER GUN AFTER RINGS HAVE BEEN SHRUNK ON.

The influence of this excellent training is evident in the work now produced at Havre and which we propose to describe in considerable detail, illustrating, as it does, not only the most advanced practice of ordnance manufacture in France, but also a practice which is able to hold its own with that of works of far older date and greater celebrity; in fact, the most remarkable feature of this, the latest development of the Forges et Chantiers, is that it has sprung up almost suddenly into fame and must be reckoned as one of the great gun factories of the world. The Havre ordnance works are indeed worthy of the great company to which it belongs, a company that employs about 8,000 workmen, and has since it was first established supplied shipping to home and foreign customers to the value of 500,000,000 francs.

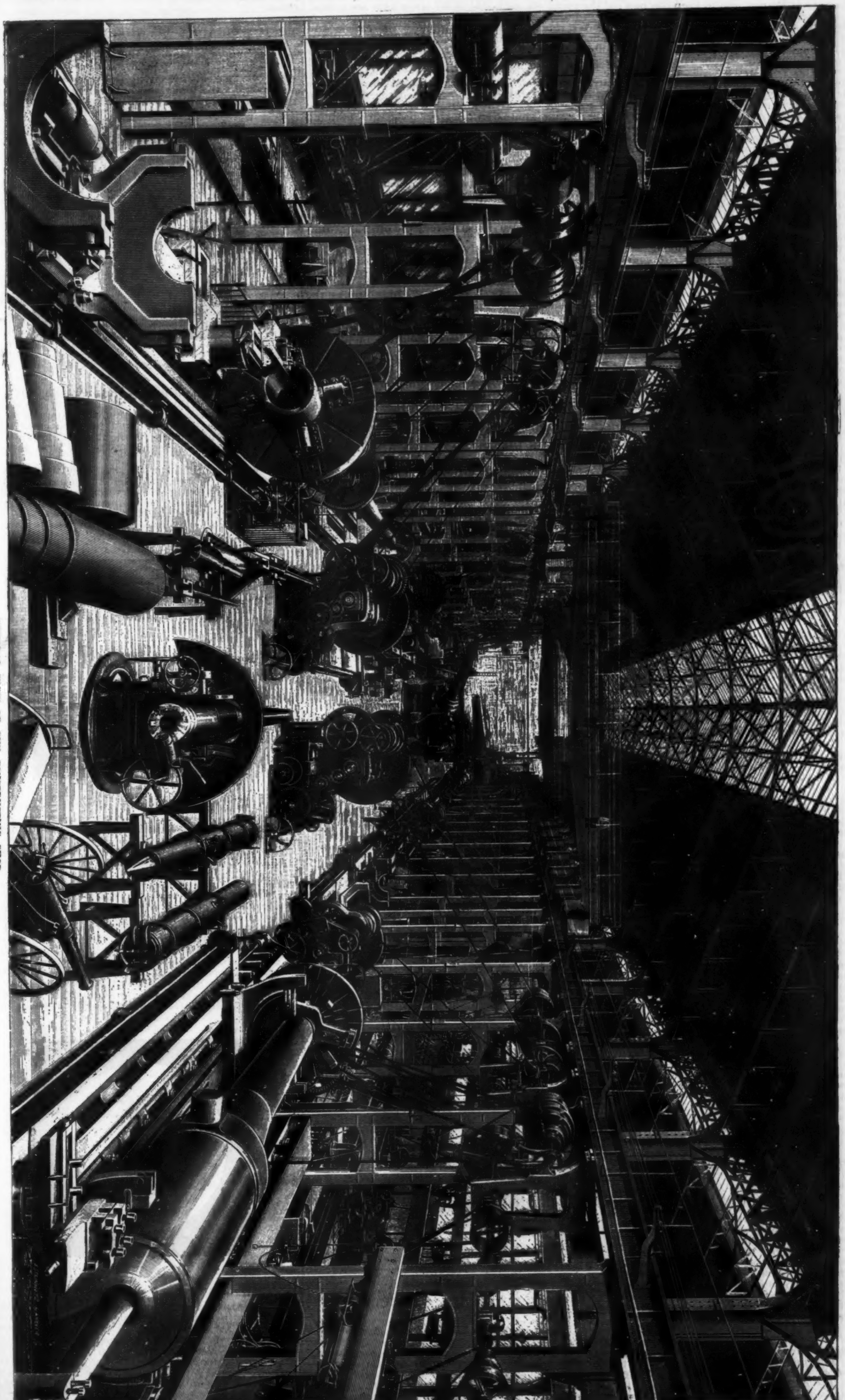


TRAVELING CRANE IN GUN SHOPS SHIFTING A 33 CENTIMETER GUN.

The Societe des Forges et Chantiers de la Mediterranee was one of the most active assistants of the French government during the Franco-German war, toward the close of which, when the state factories had utterly broken down, it manufactured large quantities of guns and other war material. During this trying period no less than 300 pieces of artillery of various calibers, as well as 1,200 carriages, were made at Marseilles, and before the close of the war a well organized ordnance department had been developed there.

When peace was restored, all use for this department came to an end, for the state wanted no more guns just then, and sales to foreigners were impossible. Quite a number of years elapsed before the much needed change was made, years during which many people besides M. Thiers occupied themselves in bringing it about. The strong incentives of patriotism and profit were indeed great enough to maintain a constant pressure on the government, and among those who kept the subject always to the front were M. Dupuy de Lome, vice-president, and M. Douet-Pastre, general manager of the Forges et Chantiers company. When the society again began the manufacture of ordnance, it was under totally different conditions, and with a far wider scope; it was not at Marseilles that the new

THE GUN FACTORY OF THE FORGES ET CHANTIERS DE LA MÉDITERRANÉE AT HAVRE.



GENERAL VIEW OF GUN CONSTRUCTING SHOP.

works were started, as it was considered for every reason preferable to have a large branch establishment at the opposite extremity of France, and to keep the new works entirely distinct from the parent company. And it was not by any means as a factory for the service of the state, because while full privileges were granted as regarded foreign trade, the government arsenals proposed to retain in their own hands the manufacture of all ordnance required for the army and marine. The Forges et Chantiers company, therefore, commenced their new factory with the bold determination of entering into competition with the gunmakers of England and Germany—with Elswick and Essen especially. At the same time, should any necessity unfortunately arise in the future, they would be in a position to render aid to the country, very different to that they had given in 1870. The works were started under the best possible conditions, all the experience painfully gained during the war was available; the rapid progress made by a few manufacturers was at the same time an incentive to competition and afforded valuable sources of information; the possible field for business with foreign customers was almost unlimited, while the certainty of being able to aid the country in the event of necessity gave additional zest to the enterprise. M. Canet, who was from the commencement appointed as chief engineer of the gun factory, was thoroughly fitted for the responsible position for which, as we have seen, his previous experience had prepared him, and he started with a somewhat bold but very practical scheme for the organization of the works. This was nothing less than a complete programme for the manufacture of so large a series of ordnance that it should comprise every possible variety that could be required by any nation, and for every purpose according to our present lights on the subject; at the same time, while introducing into his plan a large number of original and often very bold details, he held fast to all that experience had taught should be followed in the design and manufacture of heavy guns.

One part of his plan was so to arrange the factory that it should be adapted to the production of a large series of different natures and calibers. This series comprises seven types of mountain and boat guns of 75 and 84 millimeters (2·95 in. and 3·31 in.); for quick firing guns, three types of each, and from 6·5 to 15 cent. (2·56 in. to 5·90 in. bore). The other types provided for were as follows: Mortars of from 7·5 to 34 cent. bore (2·95 in. to 13·39 in.); howitzers from 7·5 to 34 cent. (2·95 in. to 13·39 in.); short and long siege guns from 7·5 to 34 cent. (2·95 in. to 13·39 in.); siege guns from 90 to 270 millimeters (3·54 in. to 10·63 in.); and naval and coast defense cannon from 9 to 37 cent. (3·54 in. to 14·57 in.). Each of the calibers for naval service and coast defense was further subdivided into five types of 25, 30, 36, 43, 50 calibers in length. By this system there exist no less than twelve different classes divided into a number of types.

Each different class of gun has its own form of breech mechanism, the leading principles being alike in all, but the details varying with the purpose of the piece; there are in all six distinct patterns for field and mountain guns, for boat, quick firing, coast defense, siege, and the heaviest nature of ordnance. In the same way for the various carriages, a special type is made for each class of gun, so that a complete system has been elaborated for all the variations in gun construction that are required, at all events for some years to come.

The works which are specially devoted by the Forges et Chantiers company to the manufacture of guns are in Havre, and close beside the older machine shops of the company, and with which they are connected, a very useful arrangement, as the two establishments work together, a great deal of the machine work for the carriages being done in the latter factory; this department is under the charge of M. Cazavan. All the work connected with the construction of turrets, and the whole of the hydraulic machinery, is executed at the Seyne works near Toulon, under the direction of M. Laganne. The central offices of the company are in Paris, in the Rue Vignon, and it is there that all designs for guns, carriages, etc., are prepared by M. Canet. Finally, we may mention that the artillery works are under the management of Major Roger, a French artillery officer. One of the most important adjuncts to the company's gun factory is the polygon or firing ground, which is located at Hoc, near the mouth of the Seine; it is situated not far from the works, with which it is connected by lines of railway, and is very completely appointed for the conduct of every kind of trial with ordnance of all calibers. From what we have said it will be readily understood that not only the Forges et Chantiers company, but the whole country, is proud of these ordnance works, of recent origin, it is true, but nevertheless so complete that they succeed in obtaining and executing satisfactorily orders for foreign powers, which, until recently, could not have been placed in France at all.

We may now commence a description of the factory, taken partly from a notice published a short time since by our contemporary, *Le Genie Civil*. The artillery works occupy a large rectangular space of ground bounded on the north by the railway running from Paris to Havre, on the south by the Rue d'Harfleur, to the west by the old machine shops of the company, and to the east by waste ground belonging to the company, and reserved by them for future extensions. The principal entrance to the factory is by the Rue d'Harfleur, where the offices are situated, and by which materials of a light description are brought by road; at the opposite end the railway is utilized for the transport of heavy freight. Sidings from the main line, and a complete system of lines laid down over the works, allow of an easy distribution of material, while another series of lines extending to the quays and basins of Havre give full facilities for shipping and unshipping the heaviest objects taken into or brought out of the works. The polygon is situated about four miles from the factory. The works include a large number of buildings, which occupy a total surface of about 160,000 square feet; the general arrangement adopted is that of a number of separate structures adjoining each other. These extend from north to south for a total length of 420 ft., and communicate with one another; from east to west the buildings are divided into twenty bays of about 20 ft. each; in the center is a large shop of 55 ft. 9 in. span, and a height of 30 ft. to the springing of the roof principals. The two spans adjoining this central bay, and communicating with it, are each of them 30 ft. in width and 20 ft. high to the springing of the roof. On each side of the outer bays are a number of buildings devoted to miscellaneous purposes; on the west side is an annex containing the offices, and there is here a special workshop to which reference will presently be made, 39 ft. span and of the same height. The main buildings are wholly of iron, and the roof principals are placed 19 ft. 8 in. apart, being carried on double columns that serve at the same time to support the traveling cranes; the large illustration gives a good idea of the interior of the principal shop. Considerable trouble was experienced in obtaining good foundations for these buildings and for the heavy tools they contain. The ground at this place consists of sand and marl for a depth of 30 or 35 ft., and it was necessary that the columns, as well as many of the heavier machines, should be carried on a pile foundation. Motive power for this workshop is furnished by two compound engines of the marine type, which can be driven separately or coupled together, according to requirements: each of them is of 80 horse power nominal, but they can develop 120 horse power; the ordinary working speed is 90 revolutions per minute, and they are furnished with steam by three Galloway boilers, two of which are sufficient for the engines, a third being kept in reserve. This motive power was supplied from the company's works at La Havre. Both engines and boilers are placed in one of the buildings forming the western annex to the principal shops; the main shaft of the engine is placed parallel to the axis of the buildings, so that by means of two large driving pulleys on the engine shaft power can be transmitted direct to the five lines of shafting within the works. One of these pulleys gives motion to the shafting in the central nave, the other by means of underground countershafting drives the machinery in the four other bays.

A very complete means of handling heavy masses of material is essential in these works; the central nave, where the largest machine tools are placed, is provided with two traveling cranes, one able to lift 60 tons and the other 30 tons, but they are so arranged that they can be worked in combination, and in this way can handle masses weighing 90 tons. The western bay is furnished with a traveling crane of 30 tons, besides hand winches, and the eastern bay has a 10 ton traveler; in addition the northern end of the western bay, in which steel rings and jackets are stored, has a 7 ton hand winch. All the traveling cranes are driven by endless belts, and are controlled by friction gearing. The engraving shows the interior of the carriage shop. The pit constructed for shrinking on the steel jackets and re-enforcing rings is 26 ft. 3 in. deep and about 8 ft. in diameter; it is situated at the north end of the central nave. This pit is fitted with all the appliances required for heating the rings by gas, as well as for handling the heavy masses of steel that have to be raised, lowered, and shifted. We also illustrate the method of handling heavy guns in the shops during and after the process of shrinking on the rings. There are several smaller pits in which field and other light guns are put together.—*Engineering.*

NEW MECHANICAL VEHICLE.

WE cannot call the vehicle herewith illustrated a velocipede, because it is maneuvered by the hands and

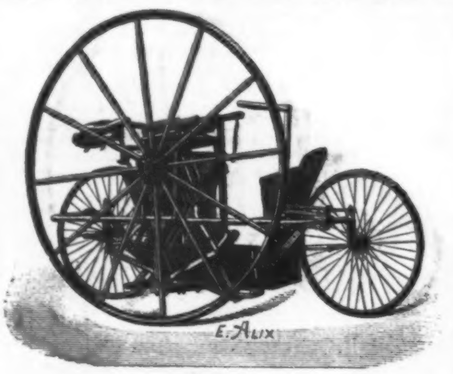


FIG. 1.

FIG. 2.

NEW MECHANICAL VEHICLE.

feet of four persons. As shown in the figures, there are three wheels: a large one, which is the driving wheel, and two small ones which serve for steering. The two occupants sitting near the large wheel move the pedals. The one in front holds the bar that causes the small wheels to move to the right or left. The two occupants sitting near the small wheels move a lever. The entire apparatus, although very strong, is extremely light, and this allows the occupants to make a good headway without fatigue.—*Les Inventions Nouvelles.*

PHOTOGRAPHY BY THE LIGHT OF THE ELECTRIC SPARK.*

By Lord RAYLEIGH, Sec. R. S.

I HAVE long wished to illustrate by instantaneous photography the many curious phenomena attending the resolution of liquid jets into drops, and the subsequent behavior of the drops during collision; but it is only recently that I have carried the desire into effect. In order to secure good definition, the exposure needs to be less than $\frac{1}{1000}$ second, and in some cases $\frac{1}{10000}$ second. For this purpose the light attending the discharge of Leyden jars seemed to be the most promising.

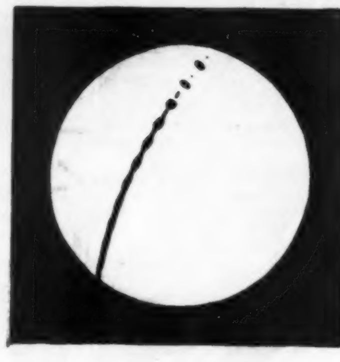


FIG. 1.

There is no difficulty, of course, in getting a photographic image of the spark itself, for in this case the light is concentrated upon a very small area of the films. But in order to photograph upon a satisfactory scale other objects by the light of the spark, the whole illumination has to be diffused over an area of several square inches of sensitive surface. Under these circumstances it requires special arrangements to secure a sufficient chemical action.

FIG. 2A.

The spark is taken between brass balls inclosed in a magic lantern. The light issuing from the condenser, still slightly divergent, falls at a distance of sixteen feet upon a large single lens of about ten inches diameter, which plays the part of a field glass. The photograpic lens, a large portrait combination by Dallmeyer, is situated about seven feet behind in the image of the lantern condenser as formed by the field glass, and is just large enough to include it. The jet to be photographed is placed parallel to the field lens, and as near as conveniently may be upon the side next the photographic camera. The preliminary focusing of the image upon the ground glass cannot well be effected by the light of the sparks. For this purpose a candle, which may stand before the lantern condenser, is substituted.

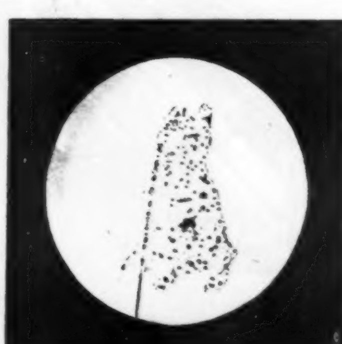


FIG. 2B.

In the earlier experiments, where jars of small capacity only were available, the images were found, on development, to be underexposed, although the impression made upon the eye by the image upon the ground glass was sufficiently startling. In later work at the Royal Institution, I have had the use of a large Leyden battery charged by a Wimshurst machine, and there has been no difficulty in securing sufficient exposure.

* Abstract of a paper read before the Camera Club Conference, and published in the *Journal* of the club.

The photographs illustrate the behavior of fine, nearly vertical fountains, and the modifications which they undergo under feeble electrical influence. In the normal condition (Fig. 1) the drops on collision rebound, and are thus scattered about over a considerable space. Under the action of electricity the drops coalesce upon collision, and thus in place of a large number of small drops the photograph shows (Fig. 2A) a smaller number of widely-separated conglomerates. It is evident that the electrification has no effect upon the original separation of the liquid column into drops.

Another set of photographs shows the details of the resolution of a larger jet (Fig. 2B). In this regularity is promoted by the operation of a tuning fork.

NEW SMOKE CONSUMING FURNACE.

THE care with which the Edison Continental Company proceeded to the installation of its central electrical stations was justly remarked. The Palais Royal Station especially may be mentioned as a model of its kind.

Among the improvements to be noted in such installations, we may mention the use of the economical and smoke consuming furnace of the Cohen system constructed by Messrs. Hermann & Cohen. The results obtained with this furnace are such that it has been decided to apply it in all the stations of the Edison Company.

The Cohen furnace realizes, in a large measure, the theoretical conditions of a perfect combustion of the fuel used, in the sense that it is divided into two parts possessing different functions. In one of these the distillation of the coal and combustion of the gases occur, and in the other the combustion of the coke takes place.

In the first part (see figure), a grate, B, receives the coal through a hopper, A', and the coal, being heated through the radiation of the dome, D, distills. Its gaseous elements, in measure as they are produced, are mixed with the air that enters through the special apertures at the sides, above the stratum of coal, at E on the one hand and through the bars of the grate, B, on the other hand. These two entrances of air, in directions at right angles, secure an energetic mixing of the gaseous fuel and air before the passage of the mixture between the grate, C, and the dome, D, where the combustion of this mixture is effected, owing to the stratum of ignited coal on the grate and to the high temperature at which the dome is kept.

The distilled fuel afterward descends upon the grate, C, which is inclined at an angle of 45°, and is there consumed. The ashes and clinkers fall upon the grate, N. The two grates, C and N, constitute the elements of the second part of the furnace, and, in fact, their draught is separated by a diaphragm, L, and this has the advantage of allowing of the entrances of the air necessary for the distillation, while reducing the draught to just what is strictly necessary for the combustion of the coke.

In order to regulate the descent of the coal and to modify the amount of the vaporization of the apparatus according to requirements, the grate, B, is movable around the axis, b^3, by means of the lever, b^4. It is actuated according to the requirements of the service. The maneuvering of this grate has the effect of substituting new coal for that which has been distilled, by throwing back upon the grate, C, the incandescent stratum placed before the grate, B, and of causing a new supply of coal to enter behind the incandescent coal.

The grate, C, is supported below by a fixed bearing bar, while its upper extremity rests upon a movable bar which is connected with the axis, M, by means of arms, I. The weight of the grate, C, is balanced, and the maneuver for lowering it, or for raising it, at the moment of firing up, for example, is easily effected through a helicoidal wheel and an endless screw.

THE COHEN SMOKE CONSUMING FURNACE.

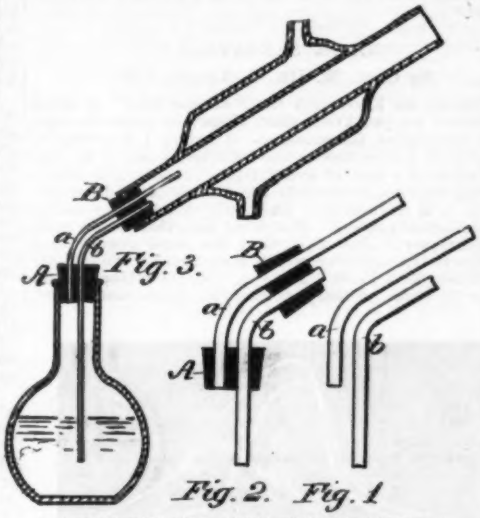
Cleaning is necessary only at the lower part of the grate, C, and the bottom grate, N. It is very easily done by the fireman, who is protected against radiation of the incandescent surfaces, and it is effected without in any way cooling the furnace, the calorific power of which, on the contrary, is increased during the operation.

The advantages of charging by a hopper, as regards the preservation of the plates, the prevention from burning, the regularity of operation, and the stability of the water level, are well known.

The smoke consuming qualities of the apparatus, as well as the notable saving in fuel, have led Mr. Vernes, engineer in chief of the Edison Company, to apply the Cohen furnace at the electric station of the Opera House and at that of the Palais Royal. In this latter station, for example, the mean combustion of fuel, which for three boilers was about $6\frac{3}{10}$ tons for 24 hours, fell to $5\frac{7}{10}$ tons as soon as a furnace of this kind was put in service.—*Le Genie Civil.*

A CONVENIENT ATTACHMENT FOR A REVERSED CONDENSER.

IN using a reverse condenser, where considerable quantities of gas must pass out from the upper end of the condenser, as in the case of the preparation of monochloracetic acid by passing chlorine gas through boiling acetic acid, when considerable quantities of HCl and chlorine gases escape, if the heat is not very carefully regulated, it often occurs that the flow of the



A CONVENIENT ATTACHMENT FOR A REVERSED CONDENSER.

condensed liquid is obstructed by passage of the gases and vapor into the condenser, and it accumulates until the tension of the vapor in the flask and the exit of the gases spurt it out. The following device I find to entirely prevent the trouble. It will be found to work to a great advantage with a reversed condenser where no gases are escaping, as the heat will need no adjustment, and the operation when started will need no attention whatever.

Bend two small glass tubes as represented in *a* and *b*, Fig. 1. Pass these through large rubber stopper, B, for flask and small one, A, for end of condenser, as represented in Fig. 2. Let *b* pass just through A, but far enough through B to reach below surface of liquid in flask. Let *a* pass just through B, but far enough through A to reach within an inch of where water bath begins, as represented in Fig. 3. Tube *a* must not touch condensing tube, especially on the bottom, as the condensed liquid would flow back into it.

The hot vapor and gases will pass out through *a*, since *b* dips below surface of liquid, and will condense above the end of *a*, as it does not reach the water bath in condenser, and will flow back through *b* into flask. The lower part of condenser will not become cool enough to condense the outflowing vapor in *a*, nor hot enough to vaporize the back-flowing condensed liquid; so we have a steady stream of vapor, or vapor and gas, flowing out through *a*, and a steady stream of condensed liquid flowing back into flask through *b*.

J. L. BESSON.

University, Ala.

MILK—WITH SPECIAL REFERENCE TO THE MANUFACTURE OF CHEESE.

By JAS. W. ROBERTSON, Dairy Commissioner.

FEED.

THE milk of the cows is a secretion of direct elaboration from their blood. Whatever interferes with the health and comfort of the animals will also affect the quality and quantity of their milk. Too much care cannot be exercised in providing feed that is cheap, succulent, easily digestible, wholesome and nutritious. The grass of early summer is too watery and weak in feeding substance to be fed alone to the greatest advantage. A judicious allowance of bran, pease and oats, oil cake or cotton seed meal will increase the milk supply and fortify the cow's system for the production of a larger quantity of milk during midsummer, fall and winter. Broadcast fodder corn does not meet the needs of milking cows. A soiling crop of some sort or sorts should be grown, to furnish plenty of green fodder at the time when pasture may be bare from prolonged dry weather. Indian corn when grown under conditions favorable to its attainment of mature size and quality—in rows or hills 3 ft. or $3\frac{1}{2}$ ft. apart, with from two to six seeds per foot in the row—yields a fodder by the use of which cows are enabled to produce the largest amount of milk, butter, or cheese per acre of land required for their support. Fodder corn is not a complete ration for the most economical production of the best milk. When it is supplemented by grass, bran, oil cake, cotton seed meal, or similar feeds, better returns for the feed consumed are realized than when it is made the exclusive diet.

WATER.

Water is nature's vehicle for carrying about most of the matter which she requires to move from place to place. The greatest bowlders were quietly clasped in her arms and without apparent effort brought from the northern ridges to the southern parts of our Dominion. The tiniest specks of nourishing matter needed to replace the worn-out tissues of the body are likewise carried to their proper places in this wonderful omnibus. The identical water swallowed by a cow to serve as a carrying medium in her blood, for the equable distribution of the elements of nutrition throughout her whole body, is made to serve a like function in the milk which she yields. If that water be impure in the first place, it is liable to carry the impurity with it throughout its whole mission, from the drinking by the cow until after its consumption by the creature which consumes the cow's product. Water which has been contaminated by decaying animal matter is specially likely to retain its pollution. The milk from the cows which drink such water is a menace and danger to the public health, and interferes greatly with the commercial value of all dairy products. There should be an abundant supply of pure water, easily accessible by the cows during hot weather. It should be furnished at a comfortable temperature during the cold weather of winter. Cows which are denied access to abundance of water will not give as much milk or milk of as good quality as when plenty of water is provided with wholesome, satisfying feed.

SALT.

Dairy cattle should have access to salt every day, and salt should be added to all their stable feed, daily. The conclusion from a series of experiments carried on in 1886 indicate that when cows are denied salt for a period of even one week, they will yield from $14\frac{1}{2}$ to $17\frac{1}{2}$ per cent. less milk, and that of an inferior quality. Such milk will on the average turn sour in twenty-four hours less time than milk drawn from the same or similar cows which obtain a due allowance of salt, all other conditions being equal. This may apply with aptness to only the parts of the Dominion remote from the sea. From Quebec westward, as far as the Rocky Mountains, cows will consume an average of 4 oz. of salt per day, while they are milking during the summer.

SHELTER.

Comfortable quarters are indispensable to the health and well-being of cows. Stables during the winter should have a temperature constantly within the range of from 40° to 55° Fahr. In summer time a shade should be provided in the pasture fields or adjacent thereto, to protect against the exhausting influence of July and August suns. In all the management of cows such conditions should be provided and such care given as will insure excellent health and apparent contentment.

MILKING.

When practicable the milking of each cow should be done by the same person, and with regularity as to time. He only that hath clean hands should be allowed to milk a cow. I say "he" because I think the men of the farm should do most of the milking, at least during the winter months. It is no more difficult to milk with dry hands than with wet. It is certainly more cleanly, and leaves the milk in a much more desirable condition for table use or manufacture. A pure atmosphere in the stable is indispensable, to prevent contamination from that source. Immediate straining will remove impurities which otherwise might be dissolved, to the permanent injury of the whole product.

AERATION.

After the straining is attended to, the milk should be aerated. Too often it is poured into one large can and left there just as the cows have given it. That neglect implies three things that are very injurious to its quality for cheese making. 1. The peculiar odor which the cow imparts to the milk will be left in it until it becomes fixed in its flavor. 2. The germs of fermentation that come in the milk and from the air have the best conditions for growth and action when the milk is left undisturbed. 3. The milk will become in a degree unfit for perfect coagulation by rennet. Hence it is needful and advantageous to aerate it for three reasons:

First, because by pouring, stirring, dipping or by trickling it over an exposed surface, there is eliminated from the milk by evaporation any objectionable volatile element that may be in it.

Secondly, because, as has already been stated, the milk contains germs of fermentation. A strange peculiarity about some of these microbes is that they become active only in the absence of free oxygen. When warm new milk is left undisturbed, carbonic acid gas is generated, and that furnishes the best condition for the commencement of action by these almost invisible creatures. After they get started they can keep up their decomposing work, even in the presence of oxygen. It is impracticable to perfectly coagulate such milk so as to yield a fine quality of keeping cheese. Coagulation by the use of rennet or milk that is ripe can never be perfect, unless it be thoroughly aerated immediately after it is taken from the cow. *Neglect of aeration will increase the quantity of milk required to make a pound of fine cheese.*

Thirdly, because the airing seems to give vigor to the germs of fermentation that will bring about an acid condition of the milk, without producing the acid. So much is this so that *it has been found impracticable to make strictly first class Cheddar cheese from milk that has not been aerated.*

COOLING.

The subsequent cooling of milk retards the process by which it becomes sour. Certain germs of fermentation exist in milk which in the acts of their multiplication split molecules of sugar of milk, each into four molecules of lactic acid. By delaying the operation of these germs the milk is kept sweet for a longer period. The cooling of the milk should never precede the aeration. A temperature of from 60° to 70° Fahr. will be found cold enough for the keeping of milk over night, when it has been previously aired.

PROTECTION.

Milk is a liquid of absorbent proclivities. It should be protected against injury that would result from exposure to impure air. A general purpose milk stand is a device specially adapted for the spoiling of milk in that way. Such a stand serves as a milk stand and also a carriage stand, both of which are legitimate uses. Sometimes it is also occupied as a hog bivouac for the convenience of these animals, the end of whose whey trough furnishes one step for the stand. Both of these latter extensions of its uses and hospitalities are all wrong.

HONEST MILK.

The employment of inspectors promises to improve the quality of the milk furnished by some patrons, whose highest moral aspiration is limited by an effort

to keep the self-appointed commandment, "Thou shalt not be found out." The adulteration of milk by the addition of water, the removal of any portion of the cream or the keeping back of any part of the strippings, is forbidden by the Dominion statutes. Any person who is found out so doing, will not escape lightly. The inspectors appointed by the dairymen's associations have been equipped with suitable and competent testing instruments and have been instructed to render every assistance to cheese-makers looking toward the prevention of adulteration and the conviction and punishment of those who may be found guilty of the practice.

MATTERS MOST NEEDFUL OF CARE.

In the following short paragraphs I have ventured to gather helpful advice on the matters most needful of care.

1. Milk from cows in good health and apparent contentment only should be used.

2. Until after the eighth milking, it should not be offered to a cheese factory.

3. An abundant supply of cheap, succulent, easily digestible, wholesome, nutritious feed should be provided.

4. Pure cold water should be allowed in quantities limited only by the cow's capacity and desire to drink.

5. A box or trough containing salt, to which the cows have access every day, is a requisite indispensable in the profitable keeping of cows.

6. Cows should be prohibited from drinking stagnant impure water. The responsibility for the efficacy of that beneficial prohibition rests wholly with the individual farmer.

7. Wild leeks and other weeds common in bush pastures give an offensive odor and flavor to the milk of animals which eat them.

8. All the vessels used in the handling of milk should be cleaned thoroughly immediately after their use. A washing in tepid or cold water to which has been added a little soda, and a subsequent scalding with boiling water, will prepare them for *airing*, that they may remain perfectly sweet.

9. Cows should be milked *with dry hands*, and only after the udders have been washed or brushed clean.

10. Tin pails only should be used.

11. All milk should be strained *immediately* after it is drawn.

12. Milking should be done and milk should be kept only in a place where the surrounding air is pure. Otherwise the presence of the tainting odors will not be neglected by the milk.

13. All milk should be *aired* immediately after it has been strained. The treatment is equally beneficial to the evening and the morning messes of milk.

14. In warm weather, all milk should be cooled to the temperature of the atmosphere after it has been aired, but not before.

15. Milk is better for being kept over night in small quantities, rather than in a large quantity in one vessel.

16. Milk stands should be constructed to shade from the sun the cans or vessels containing milk, as well as to shelter them from rains.

17. Only pure, clean, honest milk should be offered. Any deviation from that will not always go unpunished.—*Bulletin of the Dairy Commissioner, Central Experimental Farm, Ottawa.*

EXPERIMENT ON THE REFRACTION AND DISPERSION OF LIGHT.

If we fill a glass a third full of water and incline it, we shall obtain a prism that permits of a simple observation of the phenomena of the refraction and dispersion of light.

The operating may be done either in sunlight or in a

EXPERIMENT ON THE REFRACTION OF LIGHT.

dark room. In the first case, the glass is placed in the full light over a sheet of white paper, and is given such an inclination and direction as to make its axis parallel with the solar rays; then a sheet of cardboard containing a narrow slit is held above it.

The slit gives a very clear image upon the paper. Then the cardboard is moved in such a way as to bring the slit opposite the glass, care being taken that it shall be directed parallel with the surface of the liquid. The image is then masked, but there is seen to appear nearer the glass a colored image, which is the solar spectrum with all its colors. It is thus seen that there has been a deflection and dispersion of the luminous rays.

In order to easily compare the position of the two images, a second slit on a level with the other is made in the cardboard. This, in the experiment, remaining exterior to the glass, gives a permanent image that serves as a reference point.

If one has at his disposal a dark room into which enters a fascicle of sunlight, the experiment, performed in the same way, will show moreover (owing to the illumination of the particles of dust in suspension in the air and water) the two fascicles—incident and refracted. The change of direction produced at the entrance into the liquid and the spectral coloration of the refracted fascicle will be clearly distinguished.—*La Nature.*

COLOR SENSATION.*

By Capt. W. De W. Abney, C.B.

Though we know not the "reason why" of color sensation, we yet know that there are three distinct color sensations, the existence of which I have heard so eminent a physicist as Lord Rayleigh say is as well proved as the law of gravitation. I may add that I am one who boldly accepts the theory of trichromatic vision in a normal eye, and hold it as being sound physiological physics. But what has this to do with photography? Just this, that the same theory that applies to the sensitive retina may equally well apply to the sensitive plate. The eye, *i. e.*, its retina, is sensitive to three primary colors, red, green, and violet,

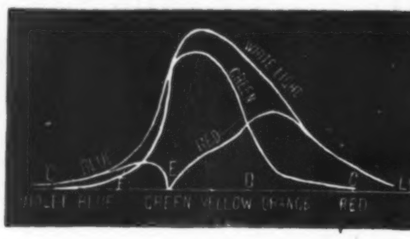


Fig. 1.

and if we take the spectrum we find that any intermediate colors can be compounded of two or more of these three colors. Thus the orange sensation is caused by a combination of the red sensation with green sensation and the blue of violet and green. Further, when we come to show graphically on paper the curves of luminosity of the three different sensations to the spectrum, we cannot but be struck with the similarity that they bear to the curves of sensitiveness of the different salts used to register the photographic image.

There is no difficulty in taking in the fact that some one particular wave length can cause one sensation in the eye, but it is harder to understand that another wave length not differing much from it can give rise not only to the same sensation, but to one or two others. The theory of sound, however, helps us in the first case. When one tuning fork is not quite in tune with another, the one sound from one will re-enforce the other to a certain extent, but as the discordance increases the re-enforcement becomes less and less, and finally vanishes altogether. So with waves of light; the waves which are in exact accord with one part of the machinery (whatever it may be) in the eye will produce a maximum effect, producing eventually a motion which gives rise to the impression of a primary color. The waves which are slightly longer or shorter than this will be only capable of giving a smaller amplitude of vibration to the same part of the apparatus existing in the eye, and consequently less intensity of that particular color sensation, till finally, as the wave lengths become shorter and longer, the amplitude of vibration in that machinery becomes *nil* or imperceptible. But at the same time that part of the machinery which is exactly in accord with another wave length, and is, consequently, another color sensation, may also respond to the same wave lengths as those which partially affect the machinery answering to the first color sensation, and for the very same cause, though it may be to a greater or less degree. Thus the same wave length, which is not in true accord with either, may cause both color perceptions to respond.

The same argument applies to three color perceptions, and would do so to more if they existed. Now a sensitive plate may be said to take the place of the retina, and the sensitive salts used to a color-perceiving tissue. The simple salts have but one color perception, but where two salts are mixed, we may have two perceptions, and when dyed plates are used, we may have two or three color perceptions. Even where one sensitive salt, the silver bromide, has been used, I have traced three distinct color perceptions, or, to speak more accurately, radiation perceptions, one situated in the violet, near G, another in the green, between F and E, and the third in the red, and extending into the infra-red. The places of maximum sensitivenes in the three correspond to three simple color perceptions, but not situated in the same place in the spectrum as those of the eye. These curves, however, differ from those of the eye color perceptions, in that while the curve of luminosity of the spectrum arrived at by compounding the latter is a smooth curve, the former is not; but the curve of photographic sensitiveness is in a series of hummocks or ridges. We can find something similar in some eyes; for instance, where there is a slight deficiency in the perception of green. Again, there is this difference, that while in the eye the luminosity curves of the red and green are the greatest, and the violet the smallest, in the silver bromide the violet is the largest, and the green and red the smallest. In fact, when the color perceptions of the eye are altered in their proportions, by looking through a pale blue solution they are very much the same as those of the photographic film already alluded to. It may be asked how and what am I driving at, and my reply is that I think that the photographic spectrum curves of sensitiveness are analogous to the spectrum curves of color perception in the eye, or, in other words, that a photographic plate has, in reality, only one, two, or three color perceptions, and that all sensitiveness to other colors is due to only partial response of the vibrating atoms in the molecule to wave lengths which differ slightly from those with which one or more perception is in accord. A study of the simple mixture of the haloid salts favors this view, and I believe that by using it as a working hypothesis, a better understanding of the apparent vagaries in the extent of sensitiveness will be attained.

I would here add that the generally adopted physiological interpretation of color perception is one which is very open to discussion. It can scarcely be conceived that even the delicate rods and cones of the retina are not much too coarse to be primarily affected by waves of light.

In the ear there is an equally delicate mechanism which is affected by vibration in the air; and we can scarcely expect the mechanism in the eye to be responsive to vibrations infinitely more rapid, and in a medium infinitely more subtile. Probably it will eventually be found that light acts on matter to produce a chemical change in it, and that the change so produced is capable by electrical currents to set in motion the mechanism required to give the sense of color. This, however, is traveling beyond the limits I have set myself to keep, and I leave it there.

I have to ask those of you who are interested in theory to take this hypothesis into your consideration. My late researches into the sensitiveness of various compounds, recently published by the Royal Society, have made me offer it to this conference.

Quite recently we have had an announcement that a Herr Veresez has achieved photography in natural colors, and that it is a printing process. In the paragraph which appeared in the *Standard* the name of Dr. Eder appears as supporting the discovery. Were it not that the statement in some degree has received an *imprimatur* by such a name being connected with it, one would at once have discarded it as one of those periodical outbursts of journalistic credulity which are so often rife at certain seasons of the year. There is one thing which is admitted, viz., that although red and orange have been secured, they fade in the light.

Now, as I pointed out in my address to section A of the British Association, photography in natural colors is a *fait accompli* of many years' standing, but the process is so long, and the results so evanescent in light, that there has been no practical use of the discovery so long ago made. Before we can hope to attain the goal which so many have tried to reach, at least two things have to be accomplished—the first, diminution in exposure of the sensitive surface, and the second, a means of preventing the print fading in white light, which is commonly called fixing the print.

That the first may be done I will not deny, but I think a glance into the physics of the matter will at once demonstrate that the second desideratum is chimerical, for the following reasons:

There is no known element which is capable of taking on itself three colors, owing to the molecular change, and this would be the least number of states in which it must exist to reproduce all the spectrum colors. We may, therefore, at once dismiss from the possibilities that a printed image in colors can be composed of elemental matter. This makes the possible image a compound which has to be acted upon by light. The action that must take place on such a compound must be either a reducing action or an oxidizing action (probably both), or else a molecular rearrangement. In the case of chloride of silver, which after a preliminary exposure to the light can be impressed by the spectrum colors, I have found that the blue end of the spectrum is reproduced by reduction, and the red end by oxidation, there being a position where there is a combination of both. We can conceive matter to be so composed molecularly that colored light may sift out certain molecules which shall in the aggregate reflect red light when the rays acting on them are red, or, when green light acts on them, reflect the green rays, and so on. Let us fix our attention on the molecular aggregations which reflect red light.

Since red light is reflected, it follows that all the rays existing in white light are absorbed, except the red rays, and we know that when absorption takes place, then internal work of some kind must be performed. In the spectrum, where these colors are produced on the sensitive surface, it must be recollected

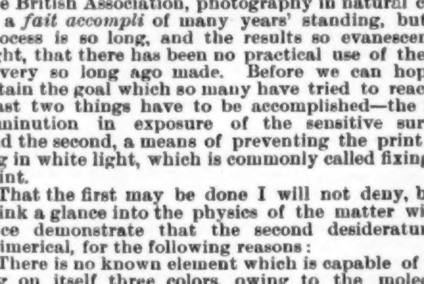


Fig. 2.

that no blue light acts on the part exposed to the red rays, and is, therefore, during that exposure incapable of doing any work in the molecules. Now, the very fact that the molecules are ready to arrange themselves into aggregations reflecting different colors shows that they are very susceptible of taking a new form of aggregation, and those which had aggregated into red reflecting masses by the action of the spectrum would be the first to rearrange themselves into blue reflecting aggregations when acted upon by the blue rays which they absorb. The blue reflecting aggregations would

* Abstract of a paper read before the Camera Club Conference, and published in the *Journal* of the Club.

also be the first to rearrange themselves as red reflecting aggregations under the action of red light, and so on. Red, green, and blue reflecting aggregations—arrived at by exposure of the matter to the spectrum colors on subsequent exposure to white light, which is a combination of the three colors—must, therefore, rapidly change to a neutral tint, following out the above reasoning; and this is found to be the case in the photographs in natural color taken up to the present time. We may take it, then, that no mere rearrangement of molecular groupings by colored light can remain stable in white light. Let us see if there is a probability of fixing the color by chemical means. Fixing would mean removal of some matter still sensitive to light. As from the nature of things such matter is part of the molecular aggregation which causes the color to be reflected, it is evident that the removal of a part of such aggregation must at once change the color. If fixing be attempted by adding to the molecular aggregation, the same reasoning applies. We therefore are in this quandary as to a printing-out process in natural colors: If the color be produced by change in composition of the matter acted on, it must be fixed by chemical agencies, which means destruction of color. If it be formed by altered molecular arrangement, white light must of necessity alter its color.

A process in natural colors which depends on development is out of the range of probability, as I have already stated in my British Association address. An embryo photographic image in natural colors might be possible, but to imagine that a colored image can be built up by chemical means, such as by the deposition of silver on such image, is to endow the depositing atoms with a discriminative judgment which, so far as is known, not one has the slightest symptom of possessing.

It will be seen from this that I am no believer in the discovery of a really practicable process for producing photographs in natural colors. We may wish every success to the gentleman who is making these researches, but the telegraphic description in the *Standard*, to my mind, does not require to be read between the lines to see that there is a great deal more of hoped for than of accomplished success in what has een done.

THE ROYAL SOCIETY SOIREE, 1890.

WE give a brief summary of some of the principal objects of interest which were exhibited on the occasion of the annual conversazione given at Burlington House on the 14th of May, by the president and council of the Royal Society.

In the first room Professor Burdon Sanderson, F.R.S., and Mr. G. J. Burch showed experiments and photographs illustrative of the use of the capillary electrometer for investigating rapid changes of electrical potential; these demonstrations were made by means of the limelight, the photographs and phenomena being projected on a greatly enlarged scale on the screen. The capillary electrometer employed by Professor Burdon Sanderson is practically the same as was devised by Professor Marey, which was itself a modification of that of Lippmann.

The apparatus employed by Professor Burdon Sanderson is so extremely sensitive, and the electro-physiological phenomena investigated by him are so very minute, that special precautions have to be taken to eliminate local electrical action taking place at all points throughout the circuit which might vitiate the accuracy of the measurements, and with this object in view, non-polarizable electrodes are employed for placing the organic objects under examination into the circuit of the potentiometer.

In the same room Dr. Augustus Waller exhibited the effect of electrical variations in the human heart, as well as in that of the dog.

Room No. 2 was exclusively devoted to geology, which on this occasion possessed a special feature of interest on account of the recent discovery of accessible coal in the south of England.

The director-general of the Geological Survey showed a series of specimens illustrative of deep borings in the south of England, including specimens from Richmond, Crossness, Kentish Town, Meux's Brewery, Streatham, Turnford, Ware, Chatham, Gayton, Orton, Harwich, and Swindon, and on the wall of the same room was hung a large map on which the positions of the above borings were marked.

Mr. Topley exhibited a sketch map showing the positions of the deep borings which have been made in the south of England, and the probable positions of the coal basins of the southern countries and of the northwest of France.

The instrument exhibited in the council room by Mr. G. J. Symons, F.R.S., to which he has given the name Brontometer, and to which we briefly alluded lately, has been designed by Mr. Symons, conjointly with the eminent firm of meteorological instrument makers, MM. Richard Freres, of Paris.

This instrument may be described generally as a meteorograph designed for a special purpose, which is to record the various phenomena occurring during the passing of a thunderstorm.

It consists of an accurately controlled chronograph, of which the recording paper travels at the rate of 6 ft. per hour, so that a time interval of a minute is represented on the chronograph by a distance of nearly 1¼ in. The cylinder is driven by a clock which is controlled by a very sensitive centrifugal governor, and makes on the paper an indication every minute by a deflection of the time pen.

The velocity of the wind is continuously recorded at another point on the cylinder by a revolving anemograph, and the atmospheric pressure is recorded by another pen which is controlled by a sort of aneroid barometer of extraordinary sensitiveness; so delicate, indeed, is this part of the apparatus, that each variation of pressure represented by a rise or fall of an inch in the mercurial column is recorded on the paper by a distance traveled beneath the pressure pen of no less than 30 in., or 3 in. for every tenth of an inch variation in barometric reading; the pressure scale of the instrument being three times that of the glycerine barometer.

In addition to the automatic records to which we have just referred, there are two keys which control as many recording pens; the depression of a key by hand causing a lateral displacement of its corresponding pen.

One of these keys marks the instant that a flash of lightning is observed, while the second marks the commencement and duration of each clap of thunder, by which the distance of the point of discharge from the place of the observer may be calculated with extreme accuracy, and the relative motion of the storm center may be estimated.

In addition to these two keys are two small levers moving over graduated arcs, their corresponding pens being by them more or less displaced laterally according to the position of their respective levers, each on its own arc. The first of these enables the observer to record on the paper the commencement, variation in intensity, and termination of rain, while the other performs the same operation for hail.

As all these records may simultaneously be made on one sheet of paper having a time scale of 0·02 in. per second, it follows that the whole history of a thunderstorm, second by second, may be registered by this instrument with an accuracy that has never before been attempted.

We may add that the apparatus displays that perfection of workmanship and finish which characterizes all the instruments constructed by MM. Richard Freres.

Professors Rucker and Thorpe exhibited maps illustrating the magnetic surveys of certain districts of the British Isles, which they have been conducting, and which formed the subject of a paper read by them before the British Association at Newcastle last year.

In these maps the horizontal disturbing forces are represented, both in magnitude and direction, by arrows of greater or less length, and the vertical disturbing force is given by figures in terms of 0·00001 C. G. S. units, those which have a downward direction being called positive.

Highly interesting experiments were shown by Mr. C. V. Boys, F.R.S.

The first of these demonstrations was a thaumatrope in which photographs of the various phases passed through by a drop of water from its formation and breaking away from its support to its falling, and being absorbed into the water below, were rotated and observed in a mirror through the rapidly passing orifices in the thaumatrope disk.

The effect of forming and falling liquid drops was exactly reproduced, and demonstrated the extreme accuracy with which the series of instantaneous photographs was produced. The method of producing these pictures is thus described by Mr. Boys:

Water drops ½ inch in diameter are allowed slowly to form and break away in a liquid of slightly lower specific gravity, namely, a mixture of paraffin and bisulphide of carbon.

Photographs of these are taken in the following manner:

They are illuminated by an electric arc and large condensing lenses; a camera is placed in front and the view is rendered intermittent by a card disk with one hole near the edge made to rotate at from fourteen to twenty revolutions per second. The exposure is about $\frac{1}{150}$ part of a second.

A photographic plate about forty inches in length is fixed in a slide, which can be drawn past the lens by hand. The thaumatrope was constructed by attaching the several pictures of the series to a card disk, and afterward painting the surface black and white, following the outlines of the photographic picture. When this disk is rotated in front of a looking glass and its reflection observed through orifices pierced through it, the whole history of a liquid drop may be studied in a most remarkable manner; there is first the gathering of the drop, which gradually lengthens, then a slight constriction is formed, which diminishes to a mere thread of liquid; the next picture shows the thread broken and the drop detached, followed by a retractation of the supporting drop, which throws off a minute spherule, which is the remains of the broken thread. The drop falls, and during its descent is thrown into pulsating vibration, varying from a vertical to a horizontal ellipsoid passing through a spheroidal stage, and the pendent drop simultaneously vibrates as if it were a weighted spring.

A further and perhaps more unexpected result follows the falling into the water of the detached drop, for it rebounds and vibrates in a similar manner to the pendent drop at the top.

These phenomena are all reproduced in the most realistic manner when the photographs so produced are examined with the aid of the thaumatrope.

In the oscillating spark experiment the lenses by which the drawn-out image of the spark is projected on the screen are six in number, and are mounted, in two sets of three each, around a disk, which by suitable gearing can be rotated at a velocity of 300 revolutions per second, so that the lenses follow one another in front of the spark at a speed of 1,800 per second. The two sets of lenses are fixed to the disk at different distances from its center, so that the images formed by them on the screen do not overlap, but are projected as two concentric bands of light which are not continuous, but are made up of luminous patches of light with dark spaces between, showing the oscillatory character of the spark.

These experiments of Mr. Boys proved the greatest attraction of the evening, and the portion of the council room in which they were exhibited was crowded the whole evening until midnight.

In the Great Library, Prof. Marshall Ward, F.R.S., exhibited a highly interesting and important series of transparent photographs showing the habits and peculiarities of various trees from different parts of the world, the comparative structure and anatomy of a large number of timber trees from Europe, and some of the more prominent features of diseases in timber trees and the fungi by which some of these diseases are caused.

Mr. Shelford Bidwell, F.R.S., attracted considerable attention by his very beautiful demonstration of the electrification of a steam jet. In this experiment a small boiler supplies steam to a fine jet, and close to the orifice is fixed a little group of needles, which are in connection with one of the conductors of a Wimshurst influence machine, and, by means of a beam of limelight, a shadow of the steam cloud is projected on a white screen.

Under ordinary conditions this shadow is of a neutral gray tint, and of feeble intensity, being at times almost invisible; the moment, however, that the machine is set into action the steam is electrified by a brush discharge from the needles, and at the same instant the shadow becomes dense and well defined, and at the same time assumes a reddish brown color. The instantaneousness of the effect is well demonstrated by allowing a succession of short sparks to pass between the two terminals of the Wimshurst machine, when the changes in the shadow of the jet take place synchronously with the snapping of the sparks. Mr. Bidwell attributes the phenomena to a sudden coalescence of the minute particles of water constituting the visible jet under the influence of the electrical discharge, whereby larger globules are formed which obstruct the more refrangible rays of light. There is a most remarkable analogy between the effect produced and the darkness and lurid red glow which characterizes thunder clouds.

Mr. Killingworth Hedges exhibited specimens of a compound of carbon and steatite, to which the name "Carboid" has been given, and which is claimed to be suitable for bearings of machinery and to require no oil. Mr. Hedges showed a Gramme electric motor and some small machines fitted with bearings made of this composition.

A very interesting contribution to the interest of the evening was made by Lord Rayleigh, one of the secretaries, who showed an instrument for testing color vision. On looking into the eye piece of the instrument, two small rectangular patches of colored light may be seen one above the other and in juxtaposition; the lower of these patches is an invariable standard, and is of an orange brown tint, while the other by the turning of an index, moving on a divided arc, may be made of any proportion of a mixture of red and green, the upper patch being green at one end of the range of the index and red at the other.

The lower or standard tint derives its light from a prism reflecting the light of a lamp which is placed opposite a tubulure projecting from the side of the main tube of the instrument, and the variable tint is a mixture of the two colored beams produced by a double image prism, the plane of polarization of one being perpendicular to that of the other, and the rays are colored by being passed through films of selenite. The mixture is observed through a Nicoll's prism, which forms the eye piece, and by the rotation of which the proportion of the two colors is determined. Lord Rayleigh exhibited, also, the polarization of light by means of crystals of chlorate of potash. Dr. Alexander Hodgkinson showed also a collection of iridescent crystals of chlorate of potash illustrative of the production of color and its intensification by reflection from multiple thin plates.

Mr. Walter G. Gregory exhibited what he calls an electric radiation meter for obtaining quantitative measurements of the intensity of the radiations emitted by an electric oscillator, by what is known as the Hertz effect. In this instrument a fine platinum wire is stretched through the middle of a long glass tube, being firmly attached to the tube at one end, while the other is attached to a fine helical spring made by winding a thin metallic ribbon round a cylinder; as the wire elongates the spring rotates, its motion being magnified by a small mirror attached to it which reflects on a scale the image of a brightly illuminated wire. Although the platinum wire is unconnected with any source of electricity, the Hertz effect induced in it from the distant vibrator is sufficient to heat it to such an extent as to move the image of the spot of light a considerable distance on the scale. Mr. Gregory found that to produce an equal deflection by a battery current transmitted through the wire, a current must be maintained in it of an electromotive force of half a volt, in addition to that required to overcome resistance of connections and of the parts of the apparatus.

A curious exhibition was contributed by Mr. W. B. Croft, who showed a series of breath figures produced on plates of glass by placing coins and other bodies in low relief against them for a few seconds and then breathing on the surface. After the object has been removed, an impression of the detail of the object is thereby made visible. Mr. Croft showed a pair of glass plates which had been placed one on each side of a paper printed on one side only. After ten hours' "exposure" the print appears in white letters on both plates. A number of examples were shown, in some of which the aid of electricity had been brought in.

Professor Silvanus P. Thompson exhibited a very useful piece of polarizing apparatus, which he calls an optical rotator, which is intended to be used in conjunction with certain polarizing apparatus, such as mirrors and such prisms as cannot be rotated bodily without being moved out of the axis of the beam of light.

The object of the instrument is for rotating the plane of polarization in such cases, and consists of two quarter-wave plates of mica, one of which is fixed at an angle of 45 deg. across the beam of plane polarized light, which is thus converted into a beam of circularly polarized light. The second quarter-wave mica plate, which can be rotated by any of the ordinary methods, reconverts the circularly polarized beam into plane polarized light vibrating in any desired azimuth. Dr. Thompson showed also some interesting and very simple color experiments made by a series of bottles, each of which contained two unmixable liquids greatly differing in specific gravity, and the one dyed to the complementary color of the other. Although each color is transparent by itself, the two together are perfectly opaque, which may be demonstrated either by placing a bottle containing the one color behind one containing the other, or by violently agitating the two together; thus, in a bottle having a solution of aniline green in amyl alcohol floating on water dyed with aniline red, both were quite transparent, but when mixed together the contents of the bottle became black and perfectly opaque. If left to themselves, the two liquids separate again in a few minutes and the experiment may be repeated. Dr. Thompson exhibited also a natural diffraction grating of quartz, the spectrum of which is similar to that produced by a grating ruled to 12,000 lines to the inch; for the sake of comparison a ruled diffraction grating having 6,000 lines to the inch was placed side by side with the specimen of quartz.

Professor W. C. Roberts-Austen, F.R.S., whom the Queen is about to make a C.B., showed an experimental demonstration of the recent investigations of M. Osmond on the molecular changes which take place during the casting of iron and steel. When a

piece of mild steel containing 0·5 per cent. of carbon is heated to a temperature of 1,100 deg. Cent., and allowed to cool, the cooling process passes through two points at which heat is evolved; the first of these occurs when 750 deg. Cent. is reached (marking the change of *b* or hard iron to *α* or soft iron), and the second critical point is reached at 660 deg. Cent., which is due to a change in the relation of the carbon to the iron. Professor Roberts-Austen demonstrated this phenomenon by a thermo-electric method. Within a little tube of mild steel was the junction of a thermo-electric couple, the free ends of which were kept at a constant temperature by being immersed in a vessel of water, whose temperature was constant, and wires leading to a reflecting galvanometer enabled every change in the temperature of the junction within the iron tube to be indicated by the movement of the spot of light on the galvanometer scale. The iron was heated by a blowpipe flame to a temperature above the higher critical point and allowed to cool, and the phenomenon was observed by the movement of the spot of light on the scale. As the cooling goes on, the spot slowly creeps along the scale, its motion becoming slower as the first critical point is approached, stopping dead when it is reached, and immediately after the direction of its motion is reversed, and it moves back a few divisions, showing an evolution of heat, comes again to rest and then continues its normal direction until the second critical point is reached, when a similar phenomenon occurs. These phenomena will recall to many of our readers the beautiful experiments shown last year by Professor Roberts-Austen at Newcastle, when dealing with the effects of recalescence in his lecture before the British Association on the hardening and tempering of steel.

The Royal Meteorological Society exhibited some interesting photographs of lightning flashes taken in a camera held in the hand and swayed to and fro during the storm of the 9th of June, 1889; the photographs exhibit double and multiple flashes perfectly parallel to one another. The society had also a set of photographs showing the devastation caused by the great tornado which visited Rochester, in Minnesota, on August 21, 1883. In one of these photographs a horse is shown impaled by a large branch of a tree, which had, by the force of the wind, been blown through his body, and in another a picture was given of blocks of bark, into which pieces of straw had been driven end on like so many nails driven in by a hammer.

Professor W. Grylls Adams, F.R.S., exhibited a very beautiful polariscope for measuring the angles between the optic axes of biaxial crystals. In this instrument the crystal under examination is fixed at the center of a sphere of motions, to which the optical part of the instrument can be adapted; that is to say, every conceivable motion can be given to the polarizing apparatus moving round the crystal in azimuth, or in vertical planes perpendicular to one another, or rotating on its own axis, by means of milled head adjustments; the line of collimation of the apparatus always passing through the center of the crystal. It would be impossible to give a clear description of this beautiful instrument without the aid of drawings illustrating the various mechanical motions.

An especially interesting and important exhibit was that of MM. Richard Freres, the eminent recording instrument makers of Paris, who, it will be remembered, exhibited among the *Instruments de Precision* at the Paris exhibition a series of instruments which continuously and automatically recorded the various meteorological phenomena taking place on the summit of the Eiffel tower, with which they were in electrical communication. MM. Richard Freres, at the Royal Society, exhibited a continuously recording hair hygrometer. In this instrument, which is an elaborated development of Saussure's hygrometer, the expansion or contraction of a bundle of hairs under the influence of variations in the humidity of the air raises or lowers a pen, which traces its record on a paper-covered cylinder making a revolution in twenty-four hours. We may point out that the hair hygrometer occupies an important position among humidity meters, for the reason that it is capable of working satisfactorily at temperatures near that of the freezing point of water—a temperature at which most other hygrometers are useless. MM. Richard Freres exhibited also a series of curves drawn by the anemometers at the top of the Eiffel tower, side by side with curves produced by similar instruments fixed at the Bureau Central. A comparison of these curves shows that the average velocity of the wind at the top of the tower, at a height from the ground of 994 ft., is about three and a half times what its mean velocity is at a height of 66 ft.; and a far more remarkable fact is brought out by comparing the two sets of curves, namely, that the greatest average velocity on the top of the tower is attained at eleven o'clock at night, while at the lower level, as has hitherto been observed elsewhere, the maximum velocity takes place at one o'clock in the afternoon, so that the times of maximum and minimum velocity are almost exactly reversed.

It is impossible within the limits of an article to do justice to the various objects of interest shown at the Royal Society, or even to refer to all of them, but we have said enough to show that a feast of intellectual enjoyment was provided for Sir George Stokes' guests.—*Engineering.*

THE ROYAL SOCIETY CONVERSAZIONE.

The *conversazione* held by the Royal Society on May 14 was in every way most successful. The attendance was large, and every one was pleased and interested by the programme. We note some of the objects exhibited:

The director general of the geological survey exhibited: (1) A series of specimens illustrating deep borings in the south of England. In this case was arranged a series of cores and specimens from all the deep bores which during the last thirty years have been made in the south of England in search of water. They included the borings at Richmond, Crossness, Kentish Town, Meux's Brewery, Streatham, Turnford, Ware, Chatham, Gayton and Orton, in Northamptonshire, Harwich, and Swindon. The positions of these bores were shown on the large index map suspended in the same room.—(2) Series of specimens illustrating the dynamical metamorphism of rocks. This case contained an important collection of specimens from Switzerland, Norway, and Scotland, illustrating some of the more remarkable effects of the mechanical deformation and recrystallization of rocks.

The first series was one of specimens of Triassic and Jurassic dolomites and limestones from Canton Glarus, showing the extraordinary manner in which these rocks have been squeezed and puckered. Attention was particularly directed to the evidence afforded by the fossils (*Belemnites*) of the extent to which the strata have been stretched in some parts. The second series, from the south of Bergen, showed the presence of recognizable Silurian corals and trilobites in rocks which have been so much metamorphosed as to have acquired the characters of finely crystalline phyllite or micaceous schist. The third series, from the northwest of Scotland, illustrated how a massive quartzite, full of annelide tubes, has been crushed and recrystallized until it has assumed the structure of a quartz schist, and all trace of the fossils has been obliterated. The effects of mechanical movements even among the comparatively young and soft rocks of the south of England were illustrated by two specimens placed in this case from the under surface of a "thrust plane" in the vertical chalk of the Dorsetshire coast. They showed how the chalk has been indurated, smoothed, and polished by the movement of the overlying mass. A view and section of this thrust plane were placed beside the specimens.

Specimens of minerals brought from Ceylon by C. Barrington Brown, exhibited by Prof. J. W. Judd, F.R.S. Large perfectly crystallized and clear beryl, 2,650 grammes in weight. The specimen, though water worn, exhibits the crystalline form. The color is intermediate between that of emeralds and aquamines. The specific gravity is 2·703. Fine crystal of yellow corundum (oriental topaz). Well developed crystals of corundum (sapphires, etc.). Crystal of chrysoberyl from the same district.

Maps to illustrate magnetic surveys of special districts in the United Kingdom, exhibited by Profs. Rucker and Thorpe, FF.R.S. The arrows represent the horizontal disturbing forces in magnitude and direction. The figures give the vertical disturbing force in terms of 0·00001 C.G.S. units, taken as positive when it acts downward. In some maps, regions of great downward vertical force are indicated by deeper tints. Map 1. Indications of an attracting center at sea, to the south of the Hebrides. Map 2. Horizontal disturbing forces at stations near the boundaries of a district in Yorkshire and Lincolnshire, within which there is a locus of attraction. Map 3. Regions of high vertical force within the above district. The highest observed values are at Market Weighton and Harrogate. Map 4. Ridge line or locus of attraction drawn (continuous line) by connecting stations of maximum vertical force, and dotted line by connecting points midway between the stations at which the direction of the horizontal force disturbance changes. Map 5. Ridge line, 150 miles long, probably correct to within five miles for the greater part of its length.

Mr. C. V. Boys, F.R.S., exhibited: (1) Oscillating spark experiment. This is a modification of the method employed by Dr. Lodge to show the oscillatory nature of a spark formed under proper conditions. Six lenses are mounted on a disk, and are made to rotate. Each forms upon a screen an image of the spark, which is drawn out by the movement of the lens into a broken band of light. The lenses are not exactly the same distance from the axis, so that the band formed by one is not overlapped by the band formed by the next. Thus the whole duration of the spark from the first to the last oscillation may be observed or photographed. (2) Photographs showing the formation of drops. Water drops, half an inch or more in diameter, were allowed to slowly form and break away in a liquid of slightly lower specific gravity, namely, a mixture of paraffin and bisulphide of carbon. Photographs of these were taken as follows: they were illuminated by an electric arc and large condensing lenses, a camera was placed in front, and the view was rendered intermittent by a card disk with one hole near the edge made to rotate at from fourteen to twenty turns a second. The exposure was about one eight-hundredth of a second. Forty inches of photographic plate were arranged in a long slide which could be drawn past by hand. Three of these multiple photographs are exhibited. The thaumatrope was made by sticking the separate parts of the last series round a card disk, and afterward painting the surface black and white, following the outlines of the photographs exactly. The thaumatrope clearly shows the gradual formation of the drop and the spherule, the oscillation of the pendent drop immediately afterward, the rebound of the spherule from the pendent drop, the oscillation of the large drop as it falls, and its rebound from the water below into which it fell. Other photographs are shadows of water jets cast upon a photographic plate by the action of a small distant spark, a method invented by Mr. Chichester Bell. The remainder are photographic shadows cast by a water jet upon a rapidly moving plate by the intermittent light of an oscillating spark. These clearly show the movement of the separate water drops.

Sugar cane (*Saccharum officinarum*) seed and seedlings, exhibited by Mr. D. Morris. There appears to be no authentic record of any really wild station for the sugar cane, and the fruit has not hitherto been figured or described. At Barbados, several times during the last twenty years, and more recently by Prof. Harrison and Mr. Bovell, self-sown seedlings of the sugar cane have been observed. The subject was taken up systematically in 1888, and about sixty of the seedlings raised to mature canes. Many of these exhibited well marked characteristics differing from the varieties growing near them. Careful inquiry has shown that canes known as the "purple transparent" and "white transparent," and possibly also the "Bourbon" cane, produced seeds in very moderate quantities. Spikelets received at Kew have been examined and the seed found *in situ*. It is anticipated that, by cross fertilization and a careful selection of seedlings, it will now be possible to raise new and improved varieties of sugar cane, and renew the constitutional vigor of plants that have become deteriorated through continuous cultivation by cuttings or slips. Great importance is attached to the subject in sugar-producing countries, as it opens up an entirely new field of investigation in regard to sugar cane cultivation.

Prof. H. Marshall Ward, F.R.S., exhibited a selection of transparent photographs, showing (1) the habits, etc., of various trees from different parts of the world; (2) the comparative structure and anatomy of several European timbers; and (3) some of the more prominent features of diseases of wood, etc., and fungi causing them.

The electrification of a steam jet, exhibited by Mr. Shelford Bidwell, F.R.S. The shadow of a small jet of steam cast upon a white wall is, under ordinary conditions, of feeble intensity and of a neutral tint. But if the steam is electrified, the density of the shadow is at once greatly increased, and it assumes a peculiar orange brown hue. The electrical discharge appears to promote coalescence of the exceedingly minute particles of water contained in the jet, thus forming drops large enough to obstruct the more refrangible rays of light. It is suggested that this experiment may help to explain the intense darkness, often tempered by a lurid yellow glow, which is characteristic of thunder clouds. See *Phil. Mag.*, Feb., 1890, p. 158.

Mr. Killingworth Hedges exhibited: (1) Gramme dynamo worked as a motor, fitted with bearings of a new carbon composition, which does not require oil for lubrication. (2) Vortex speed indicator, driven by the above, fitted with oilless bearings.

Lord Rayleigh, Sec. R.S., exhibited: (1) An instrument for testing color vision. (2) Polarization of light by chlorate of potash crystals.

Photographs of eggs of the great auk, exhibited by Mr. Edward Bidwell. There are 67 recorded eggs of this extinct bird, of which 45 are in Great Britain. The collection of photographs exhibited consists of two views each of 53 of these eggs, photographed to scale.

Specimens of Simony's lizard (*Lacerta Simonyi*), from the lonely rock of Zalmo, near the island of Ferro, Canaries, exhibited by the Zoological Society of London. A rare lizard, only known from this spot, and said to feed on crabs. These lizards were obtained by Canon Tristram, F.R.S., during his recent visit to the Canaries, and presented to the Zoological Society by Lord Lilford.

Electric radiation meter, for obtaining quantitative measurements of the intensity of the radiations emitted by an electric oscillator, exhibited by Mr. Walter G. Gregory. Its action is based on measuring the increase of length of a stretched wire, or strip of metal, when heated by the currents induced in it by the rapidly varying field of force. In the instrument exhibited, the elongation of a fine platinum wire is shown by attaching to one end of it a fine helical spring made by winding a thin metallic ribbon round a cylinder. As the wire extends the spring rotates, and the motion is further magnified by a small mirror which reflects the image of a wire on a scale. The oscillator is of the usual type, and is worked by an induction coil and four accumulators, the latter kindly lent by the Electric Construction Corporation.

Breath figures, showing that polished surfaces placed near to bodies in low relief often take an impression of the detail, which is made visible by breathing upon the surface (the period of exposure varying in different circumstances), exhibited by Mr. W. B. Croft. (1) A coin is lightly pressed on a freshly split surface of mica for thirty seconds; the mica takes a breath figure of the detail of the coin. (2) Paper printed upon one side has lain for ten hours between two plates of glass; the print appears in white letters on both. Part of this phenomenon, although not with print, was noticed by Moser in 1840. (3) Sometimes the print appears in black letters; the same impression may change from white to black. (4) Coins are put on the two sides of a piece of glass and electrified for two minutes; each side has a perfect impression of that side of the coin which faced it. An electrotype plate may be reproduced in a similar way. These effects were partly indicated by Karstens in 1840. (5) An electric spark is sent across glass. Five superposed bands appear, black and white, of decreasing breadths, as well as three permanent scars. Riess, 1840. (6) The microscope shows water particles over the whole surface, larger or smaller as the effect is black or white.

Prof. Silvanus P. Thompson exhibited: (1) Optical rotator. This apparatus is for rotating the plane of polarization of light, and is intended to be used in conjunction with polarizing reflectors (black glass mirrors, etc.), which do not permit of being bodily rotated around the axis of the beam of light. The principle of the new rotator consists in the employment of two quarter-wave plates of mica, one of which is fixed at 45 deg. across the plane-polarized beam of light, which it thus converts into circularly-polarized light. The second quarter-wave plate, which can be rotated by a simple gear, reconverts the circularly-polarized beam into plane-polarized light, vibrating in any desired azimuth. (Constructed by Messrs. Newton & Co.) (2) Natural diffraction grating of quartz. This specimen of iridescent quartz exhibits diffraction-spectra corresponding to those of a grating ruled to 12,000 lines to the inch. A microphotograph taken by Mr. C. L. Curteis, with a Reichert's apochromatic (3mm.) lens, shows the nature of the minute structures of the specimen. For the sake of comparison, a diffraction-grating of 6,000 lines to the inch, photographed on glass, is exhibited beside the piece of quartz. (3) New straight-vision prisms, consisting each of a single prism of Jena glass, of very wide angle, immersed in cinnamic ether. The materials having identical mean refractive index, rays of mean refrangibility pass straight through. (Constructed by Messrs. R. & J. Peck.) (4) Color experiments. Two liquids incapable of mixing are placed over one another in a flat bottle. They are chosen so that each absorbs all the rays that the other one can transmit. Though each is transparent, they are jointly absolutely opaque. They are also opaque when shaken up together.

Experimental illustration of the recent investigations of M. Osmond on molecular changes which take place during the cooling of iron and steel, exhibited by Prof. W. C. Roberts-Austen, F.R.S. In the case of mild steel, containing 0·5 per cent. of carbon, as it cools down from a temperature of 1,100 deg. C., two points may be observed at which heat is evolved. The first of these occurs at 750 deg. C., and marks the change of *b* (or hard) iron to *α* (or soft) iron. The second evolution of heat is observed at 660 deg., and is due to a change in the relation of the carbon and iron. M. Osmond, in continuing an investigation made by Roberts-Austen, has shown that the presence in iron of elements with small atomic volumes retards the change of *b* to *α* iron, and, conversely, elements having large atomic volumes hasten the change.

Specimen of phosphorous oxide, and apparatus for preparing same, exhibited by Prof. Thorpe, F.R.S.

and Mr. Tutton. This substance has been shown by the exhibitors to be represented by the formula P_4O_6. It crystallizes in monoclinic prisms melting at 22 5 deg., and boils in an atmosphere of nitrogen or carbon dioxide at 173 deg. Cold water dissolves it with extreme slowness, forming phosphorous acid. With hot water, strong caustic alkalies, chlorine, bromine, and alcohol, it reacts with great energy, generally with inflammation. Oxygen slowly converts it, at ordinary temperatures, into phosphoric oxide, and under diminished pressure the combination is attended with a faint luminous glow similar to that observed in case of phosphorus. No ozone, however, is formed. At slightly higher temperatures the oxidation is brought about instantly with production of flame. Phosphorous oxide possesses the smell usually attributed to phosphorus, and which is identical with that noticed in match manufactories. It is highly probable, as Schonbein surmised, that the element phosphorus is without smell, and that the smell ordinarily perceived is due to a mixture of ozone and phosphorus oxide. Phosphorus oxide is highly poisonous, and it is not improbable that phosphorus necrosis is caused by this substance.

Photographs of the spectrum of the nebula in Orion, exhibited by Prof. J. Norman Lockyer, F.R.S. These photographs were taken in February with the thirty-inch reflector at Westgate-on-Sea, the exposures varying from two to three hours. The one taken with a three hours' exposure (February 10) shows about 50 lines between λ 500 and λ 373, but many of them are only visible with difficulty, especially in artificial light. The Henry Draper memorial photograph of the spectrum of P Cygni was shown for comparison, and it was seen that all the bright lines were among the brightest in the nebula. This argues in favor of the view that stars with bright-line spectra are of a nebulous character.

Photograph of the two clusters (33 and 34 H VI.) in the sword handle of Perseus, showing remakable coronal and festoon-like groupings among the stars on several parts of the photograph, exhibited by Mr. Isaac Roberts. These clusters are quite free from nebulosity, and in this respect they differ from other clusters which Mr. Roberts has photographed; for those clusters are involved in faint but distinct nebulosity.

The larvæ of amphioxus, exhibited by Prof E. Ray Lankester, F.R.S.

A selection from the butterflies collected in the great equatorial forest of Africa by Mr. William Bonny, one of Mr. Stanley's staff, exhibited by Mr Henley Grose-Smith. Little was known of the Lepidoptera of this part of Africa; few of the species collected by Mr. Bonny have been previously recorded from that region and nine are new to science. The collection includes, among others, the great *Papilio antimachus*, also *Papilio zalmoxis*, and many west African species.

Collection of iridescent crystals of chlorate of potash, to illustrate the production of color and its intensification by reflection from multiple thin plates, exhibited by Dr. Alex. Hodgkinson.

Dr. Alexander Muirhead exhibited: (1) some patterns of Dr. Lodge's lightning protector for cables and for telegraphic work generally. In these instruments a series of air gaps, separated by self-induction coils, are offered to the lightning or other high tension currents which have got into the line. The greater part of the flash jumps the first air gap, most of the residue jumps the next, and so on, until after four or five dilutions nothing is left which can break down the thinnest insulation, or appreciably affect even a delicate galvanometer connected to the protected terminals.—(2) Muirhead's portable form of the Clark standard cell, in cases, with thermometer.—(3) Standard condenser, one-third microfarad, with Dr. Muirhead's certificate.—(4) Set of Thomson & Varley slides, small. (5) Saunders' capacity key, suitable for Dr. Muirhead's capacity test. (6) Saunders' reversing key.

Specimens of aluminum and alloys manufactured by the Aluminum Company, limited, exhibited by Sir Henry E. Roscoe, F.R.S. Pigs of aluminum, 99 per cent. pure Castings in aluminum, rough and finished. Specimens of aluminum, soldered. Aluminum wire, sheet and drawn rod. Aluminum medals, plain and gilt. Cast aluminum bronze and brass, showing (*a*) tensile strength and elastic limit; (*b*) twisting stress; (*c*) thrusting stress, long specimens; (*d*) thrusting stress, short specimens. Stampings in aluminum bronze, rough. Ten per cent. aluminum bronze, twisted cold. Five per cent. aluminum bronze, worked hot and cold. Aluminum brass, worked hot and cold. Aluminum bronze and brass sheet.

Specimens illustrating ancient copper and bronze from Egypt and Assyria, exhibited by Dr. Gladstone, F. R.S. The collection consists of borings from tools found by Mr. Flinders Petrie, at Kahun, in Egypt, and which belong to the XII. Dynasty—about B. C. 2500; also from other tools found at Gorub, which belong to the XVIII. Dynasty—about B. C. 1450. There are also fragments of Egyptian bronze figures from Bubastis, and of Assyrian bronze from the gates of the palace of Shalmaneser II., at Balawat, about B. C. 840, as well as two pieces of slag from the old copper mines of the Sinaitic peninsula, which were worked by the Egyptians in very early times, and discontinued after the XVIII. Dynasty. The principal point illustrated is the fact that the earliest metal implements were of copper, containing a very little arsenic and tin, probably as accidental impurities, and that afterward tin was added to the copper in increasing proportions with the object of producing a hard alloy

Mr. Percy Newberry exhibited by permission of Mr. W. M. Flinders Petrie: (1) Three pages of an ancient Egyptian book on medicine written on paypyrus, by a scribe named Usertesen Sen, in the twenty-sixth or twenty-fifth century before Christ. This papyrus, together with a number of others of the same date, referring to miscellaneous subjects (letters, legal documents, accounts, a fragmentary treatise on mathematics, etc.), was recently discovered by Mr W. M. Flinders Petrie, during excavations in a ruined town of the XII. Dynasty, at Kahun, in Central Egypt. It contains directions for the use of midwives, written in black and red ink, in hieratic characters (a cursive or written form of hieroglyphics).

The black ink is used in the body of the work for the symptoms, diagnoses, and prescriptions, and the red ink is used at the heads of the sections.

The following translation of the last two and a half lines of the first page will serve to show the kind of directions given in this ancient work:

"*Treatment of woman* * who is pained in her legs and in all her limbs, as one who is beaten. *Say with regard to her*,* it is the growth of the *at* (vulva). *Do thou with regard to her* * thus: Let her eat grease until she is cured."

(2) Facsimile of an unpublished papyrus preserved in the British Museum containing medical prescriptions written in the Egyptian hieratic writing of the XIX. Dynasty (B. C. 1400–1200). This papyrus is chiefly interesting from the fact that it contains prescriptions copied from an earlier work, now lost, which is said (by the ancient copyist) to have dated from the IV. Dynasty (*circa* B. C. 4000). Facsimiles of these two papyri, together with translations, notes, etc., will shortly be published, under the editorship of Mr. F. Ll. Griffith and Mr. Newberry.

Egyptian spear head of bronze, bearing the name and titles of Kames, a king at the end of the XVII. Dynasty (*circa* 1750 B. C.) exhibited by Dr John Evans, Treas. R.S. The blade is cast, and the socket is made of hammered bronze, and these two pieces that form the weapon seem to have been "burnt" together.

MM. Richard Freres, Paris, exhibited: (1) Continuously recording hair hygrometer. This is the latest form of the Saussure hair hygrometer, so much used on the Continent, owing to its working satisfactorily when most other hygrometers fail, viz., near 32° F. In some of Saussure's instruments more than one hair was used, but in none did the apparatus give a continuous record. In the present hygrometer, the expansion and contraction of a bundle of hairs raise and lower a pen, which leaves on a paper-covered cylinder a continuous record of the humidity of any position, garden or sick room in which it may be placed.

(2) Curves produced by the anemometers on the summit of the Eiffel tower, and on that of the Central Meteorological Office at Paris. These show (1) that the average velocity of the wind on the top of the tower (994 feet) is about three and a half times that at 66 feet, and (2) that the hour of greatest average velocity on the summit was eleven P. M., whereas at 66 feet (as at most observatories) it was one P. M.; so that the times of maximum and minimum are almost precisely reversed.

(3) Isochronous regulator for electric contacts. An instrument for making and breaking electrical contact at equal intervals of time.

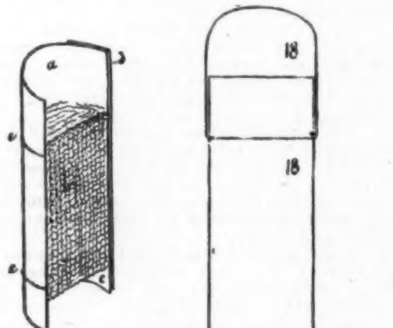
Chætopodæ, Medusæ, Ascidians, Nudibranchs, and other Invertebratæ, prepared as lantern slides, showing not only the general form, but also much of their anatomy, exhibited by Mr. H. C. Sorby, F.R.S. The success of the method depends on the fact that when soft-bodied animals are dried on glass the extreme edge dries first, and adheres firmly, so that on further drying the animal does not contract irregularly, but becomes thin and flat, and shows like a drawing projected on the plane of the glass.

In many cases the natural color is well seen, but in other cases artificial staining is used, which brings out the anatomical structure to great advantage. In some cases the specimens are best seen by reflected light, and it is then well to use a photographic slide, taken under such conditions. Some details may also be brought out to greater advantage by means of a properly developed photograph.—*Nature.*

AN IMPROVED COIL FOR MILK ANALYSIS.

By CHARLES RICE, New York.

THE advantage of employing the so-called Adams' coil (of thick blotting paper) in the estimation of milk solids, and particularly of milk fat, is generally recognized; careful trial experiments having shown that, by its use, about 0 2 per cent. more of fat can be extracted from milk than by any other method.



RICE'S MILK COIL AND WEIGHING TUBE.

While this fact is undisputed, there remain, however, some slight drawbacks, chiefly mechanical or manipulative, which not seldom inconvenience the operator. These drawbacks arise both from the material the coil is usually made of and from its shape.

The coils are made of thick blotting paper, the kind generally preferred being that known as "white demy blotting, mill 428, 38 lb." The best "Treasury" blotting paper is also used. Now, unless the coil is made rather loosely, which is accomplished sometimes by rolling up a thread with the strip of paper, it is not always easy to cause the milk to sink into the coil with sufficient rapidity. Moreover, the shape at either end is not conducive to a rapid absorption, and there is not seldom a loss from milk running down the side or escaping through a central passage.

Several modifications of Adams' coil have been proposed from time to time, one involving the use of asbestos, another that of cotton, but on trial I have found them to offer no material advantages.

A good milk coil, or cartridge, should possess the following properties:

1. It should have a shape which permits the whole amount of the milk taken for analysis (say 5 to 10 gm.) to be applied, or poured upon it quickly, without risk of loss.

2. It should be so porous that it will readily permit the escape of water, during drying, for the estimation of solids, and afterward readily admit the ether in the estimation of fat.

The material which I have found to answer best for this purpose is the so-called "absorbent gauze," also known as "bleached hospital gauze," used for surgical dressings. It is a light, open mesh cotton fabric, having about 40 fine shreds to the linear inch, and weighing about 1¼ av. ounces per square yard.

The milk coils, or cartridges, which I have been in the habit of using, consist of a small roll of this gauze inclosed in a wrapper of blotting paper, and their mode of preparation is as follows:

Spread out a square yard of the gauze on a flat surface, fold it twice in one direction to reduce it to 36×9 in., then fold it upon the long side in laps of 1¾ in. in width, so that when the whole is folded it will present a strip of 1 yard in length and about 1¾ to 1⅞ in. in width, and will consist of some 18 to 20 layers.

Now begin to roll the strip upon the narrow end, like a bandage, but not too tight, until about 5 or 5½ in. of the gauze have been rolled up; cut the slip slantingly—that is, not perpendicular to its body, but under an angle, so as not to cause "bunching" when wrapped in paper. Place the roll upon a strip of thick blotting paper 4 in. long and 2⅜ in. wide, and roll the latter over it so as to have it (the paper) project at one end about one-fourth inch over the gauze coil and about three-fourths inch at the other; then tie the coil with two threads. It will thus be 2⅜ in. long and about ⅞ in. in diameter.

The cut represents a section of one of these coils, *b* being the gauze coil, *a* and *c*, respectively, the larger and smaller free compartment, *d* is the overlap of the paper cover, and *e e* the strings.

The larger compartment (*a*) of this cartridge serves as a funnel, into which the full quantity of the milk to be tested is poured at once. A coil of this kind—intended for the smallest size of Soxhlet's extractor—will easily take from 8 to 10 gm. of milk, and the latter will never entirely soak down to the bottom of the paper wrapper. If it should soak to the bottom of the gauze coil, this will do no harm, as it is one-fourth inch above the end of the paper.

These coils may easily be prepared in quantity, then extracted in ether, and kept in a drying oven, so as to be ready for instant use.

I am in the habit of using very light glass weighing tubes, with snugly fitting covers, each being numbered both on the body and on the cap. A cartridge, perfectly dry, is first weighed in one of these tubes, and all subsequent weighings of it are made in the same tube. The milk to be examined is weighed in a separate stoppered graduated tube, then a suitable quantity of it, judged by guess and experience—corresponding to say about 8 gm.—is poured into the compartment *a* of the coil, which had previously been taken from the weighing tube. The graduated tube is weighed again, and the difference corresponds to the milk taken for analysis. The coil at once absorbs the milk, and is then transferred on a capsule to the drying oven. When dry it is weighed for determination of solids, and the fat then determined by extraction with ether in the usual manner.

The size of these cartridges may, of course, be varied according to the size of the extractor in which they are to be used.

I am quite certain that those who will try the gauze coils will prefer them to anything else heretofore proposed.—*American Druggist.*

SOAP ANALYSIS.

THIS branch of analytical work may be successfully cultivated by any pharmacist, provided he lives in a district where the use of quantities of soap for the purposes of the cloth manufacturer is on a scale which would secure an amount of analyses that would be likely to return reasonable compensation for his time and trouble. Private families rarely require their soap analyzed, being content to take on trust the assertion of the enterprising manufacturer or to rely on the more accurate knowledge derived from personal experience and observation.

Soap is extensively used in every manufacturing town for the purpose of cleansing and purifying the fabrics, and it is of the utmost consequence that it should be of a uniform character. This can only be ascertained by analysis; and however much confidence manufacturers may have in the firms which supply the soap, there is, in the nature of things, frequently occasion to have recourse to the chemist. For the purpose of ascertaining the value of soaps as detergents, the following points must be kept in view: Whether the soap is for use in the toilet, or whether it is to be employed in the general cleansing of fabrics; and for the latter purpose, the quality and delicacy of the fabrics and colors of such fabrics must be taken into consideration.

The composition of soap from a chemical point of view is essentially that of a salt—that is the product of the chemical union of a base and an acid. The acid constituent of soap is generally a mixture of stearic, palmitic, and oleic acids, the basic portion being either potassium or sodium. The potassium salt of these acids is usually known as soft soap, and the sodium salt as the ordinary hard or yellow soap of commerce. The alkali may exist in several conditions, either combined with the fatty acids, or uncombined, as carbonate, or more commonly as caustic alkali. The care with which the soap has been made, and its age, determine to a large extent the condition in which the alkali occurs.

Soap analysis is partly gravimetric and partly volumetric. For the former a balance is necessary, but as the quantities employed are not very minute, the Stone's balance already referred to will answer the purpose satisfactorily. The apparatus mentioned in our last article are also necessary in soap testing, and in addition to these a water bath will be required. Standard solutions of hydrochloric and nitric acids are necessary, and these are most convenient when prepared of normal strength. Normal hydrochloric acid ought to contain exactly 36 37 grains of pure acid in 1,000 grain measures, and is prepared as follows: Into a 10,000 grain flask are placed 1,808 grains of hydrochloric acid s. g. 1 1, and distilled water is added till the 10,000 grain mark is reached, at the required temperature (16° C.) This furnishes a solution approximately normal, and its exact strength may be determined by titration with an accurately weighed quantity of pure sodium monocarbonate. The solution of nitric acid requires

* In red ink.

to be only approximately normal. A decinormal solution of silver nitrate, prepared by dissolving 170 grains of pure silver nitrate in 10,000 grain measures of distilled water, is used for estimating the chlorides in the soap. Alcohol of 96 per cent. strength is also required, and yellow chromate of potash free from chlorides.

ESTIMATION OF FAT AND TOTAL ALKALI.

A hundred grains of the soap are dissolved in about 3 oz. of distilled water with the aid of heat, taking care that none of the contents boil over. When all the soap is dissolved, the beaker, with its contents, is brought beneath the burette containing the standard hydrochloric acid, and a few drops of litmus, or methyl orange, having been added to the soap solution, the acid is run in until a red or pink color is produced. The number of grain measures run in is now read off, and the calculation made therefrom, each grain measure being equivalent to 0·031 grain of sodium oxide (Na_2O) if hard soap is being tested, and 0·047 grain potassium oxide (K_2O) in the case of soft soap. The decomposed soap is now heated on a water bath until the fatty matter completely separates as an oily layer on the surface. It is then set aside to cool, when the aqueous portion is decanted on to a wetted filter, the fatty matter being washed with a little pure water, which is also passed through the filter. Any fat adhering to the filter is now washed out by means of warm alcohol into the beaker containing the remainder of the fat. This is dried to constant weight on the water bath, cooled, and weighed in the beaker, the weight of the beaker being subtracted. This gives the weight of the fat, and as 100 grains were taken to begin with, it also gives the percentage of fat in the sample. If the nature of the fat requires to be ascertained, 300 or 400 grains of soap will have to be treated, and the fat is separated as described.

MOISTURE.

About 20 grs. of the soap is cut into fine shavings, accurately weighed in a small porcelain capsule, and heated in an air oven for about two hours at a temperature of 120° C. After being cooled in a desiccator, the whole is weighed, and the loss in weight equals the amount of water in the quantity taken.

UNCOMBINED ALKALI.

The dried residue, viz., that obtained after drawing off the moisture, is transferred to a small beaker, with ½ fl. oz. of 96 per cent. alcohol, and dissolved. If the soap contains impurities such as carbonates, silicates, etc., those will remain undissolved, and should be allowed to settle down, and the dissolved portion decanted into a clean beaker. A few drops of alcoholic solution of phenol phthalein are added, and if a pink coloration is produced, it shows the presence of uncombined or caustic alkali. The amount of this is determined in the same way as the total alkali, by means of normal hydrochloric acid, the pink color disappearing as soon as all the free alkali is neutralized. The quantity of free alkali found is deducted from the total, and this gives the amount of combined alkali.

CARBONATES.

As a rule, carbonate is either entirely absent or present only in very small quantity. It is therefore usually neglected and classed along with combined alkali. Where it is present in considerable quantity, it may be determined in the residue insoluble in alcohol; but the process is one of difficulty, and demands considerable experience and special manipulative skill.

CHLORIDES.

Twenty grains of soap are dissolved in 800 grain measures of distilled water, and decomposed with a very slight excess of the approximately normal nitric acid, the aqueous portion being passed through a wetted filter and made up with distilled water to 1,000 grain measures. Two hundred and fifty grain measures of this solution (B), equaling 5 grs. of soap, are neutralized with sodium carbonate, and a few drops of solution of neutral chromate of potassium added. Decinormal silver nitrate solution is then run in from the burette until the red chromate of silver is permanent. The number of grain measures is then noted, and the chlorides calculated therefrom, each grain measure being equal to 0·00584 grain sodium chloride, or 0·00746 gr. potassium chloride. The titration of chlorides with argentic nitrate, and potassic chromate as an indicator, is best carried out in a white porcelain capsule, and it is desirable to have another capsule standing side by side, in order to check the color.

SULPHATES.

Two hundred and fifty grain measures of solution B are taken, and a slight excess of barium nitrate added. The whole is heated in a beater to the boiling point, and then filtered through a tared filter. The precipitate is dried on the filter to constant weight, the tare of the filter deducted, and the residue calculated as sodium or potassium sulphate.

SILICA.

Fifty grains of soap are ignited in a porcelain or platinum crucible until all the carbonaceous matter is burned off. The residual ash is treated with concentrated hydrochloric acid, and the whole evaporated to complete dryness over a water bath. This decomposes the silicates into silica (SiO_2) and chlorides of the bases. The latter, which are soluble, are dissolved with warm dilute hydrochloric acid and washed on to a filter. The residue is washed with warm water, dried on the filter at 100° C., and weighed as silica, which, if need be, may be calculated into potassium or sodium silicate.

INSOLUBLE MATTER.

The insoluble matter present in a soap refers to that portion which is insoluble in water, and usually consists of lime, sand, etc. When it exists in weighable quantities, the determination is arrived at by dissolving 100 grains of soap in water, decanting the soluble portion, washing the soluble residue thoroughly on a tared filter, drying at 110° C., and weighing.

UNSAPONIFIABLE OILS.

If it be desired to determine the amount of hydrocarbons and other unsaponifiable oils present in soap, a weighed portion of soap is dissolved in water by the aid of heat, so as to form a moderately dilute solution. This is shaken up, when cold, with a little ether, and allowed to stand until the ethereal solution separates. The ethereal layer is withdrawn by means of a pipette or separating funnel, the ether evaporated on a water bath, and the residual oil weighed. It is sometimes necessary to ascertain the nature of the fatty matter contained in a soap, and when this is required, we would recommend for consultation Allen's "Commercial Organic Analysis," Carpenter's "Soap, Candles, Lubricants, and Glycerine" (Spon), or Cameron's "Soaps and Candles" (Churchill), the first being the most useful.

When the analysis is completed the quantities of the different substances should be calculated into parts per 100 of the soap, and entered as such in the report. It will generally be found that the total results amount to 101 to 102 per cent., this being due to the hydration of the fatty acids. The report is made out in the following manner:

	Per cent.
Fatty acids	64·80
Combined alkali (soda)	8·60
Silica	0·00
Free or caustic alkali	0·01
Sodium chloride	0·40
" sulphate	0·14
" carbonate	0·00
Insoluble matter	0·70
Unsaponifiable oil	0·00
Water	26·50
	101·15

This is an actual analysis of Castile soap, and shows the average composition of soaps of this class. The fatty acid varies in commercial yellow soap from 50 to 70 per cent. We have met with samples of B.P. sapo durus showing as much as 83 per cent. of fatty acid, but these are never seen outside pharmaceutical circles. The combined alkali varies from 8 to 10 per cent., and the water from 20 to 45 per cent. Occasionally the figure for water rises as high as 50 per cent., but this is only met with in silicated soaps, the silica being added to harden the soap and to enable it to take up the maximum quantity of water.—*Chemist and Druggist.*

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